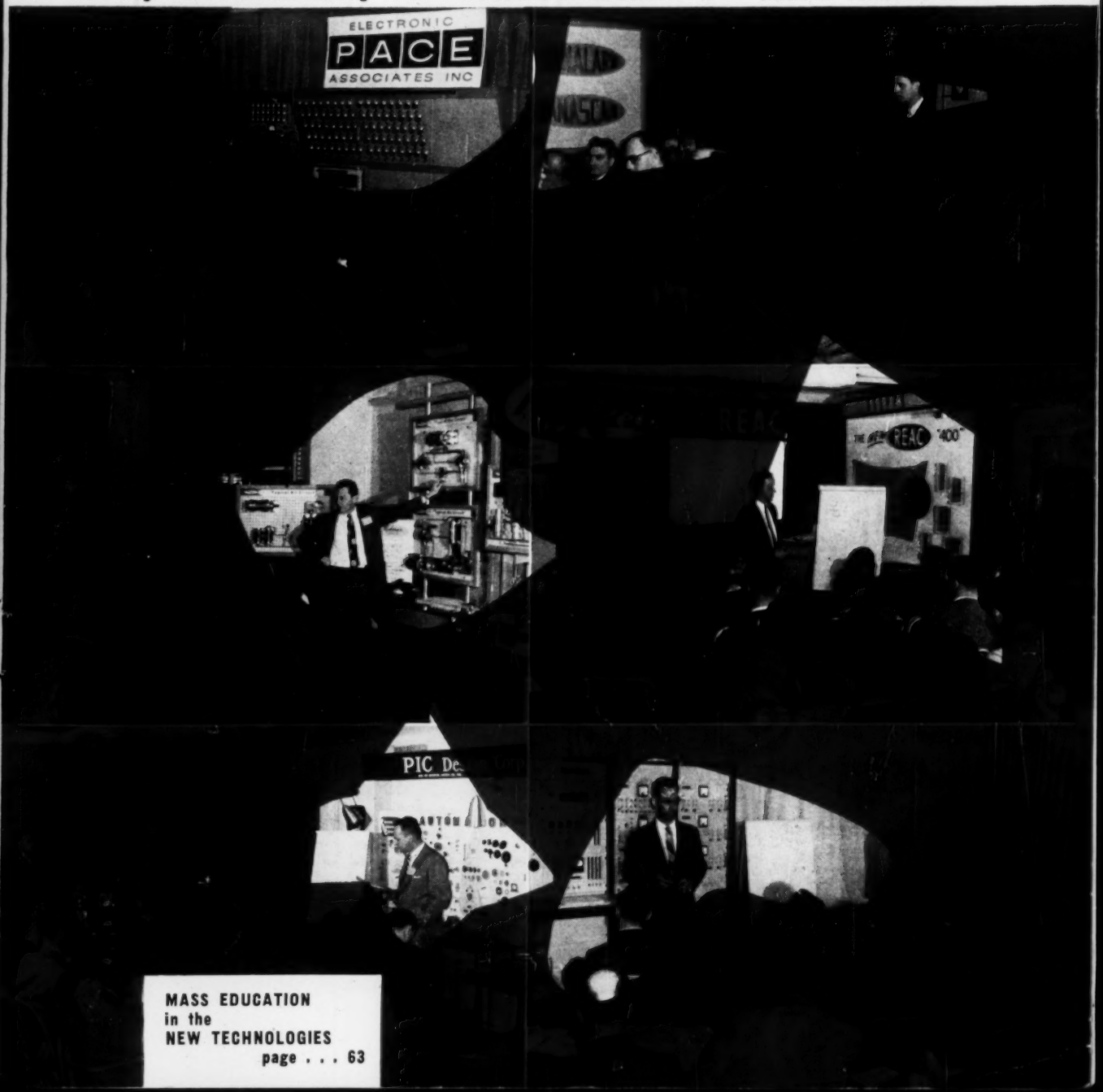
INSTRUMENTS and AUTOMATION

JANUARY 1957

Including: Instrument Manufacturing • The Journal of the SCMA • Simulation Council Newsletter



MASS EDUCATION
in the
NEW TECHNOLOGIES
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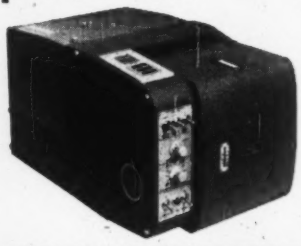
A MIDWESTERN OSCILLOGRAPH
for every recording application

This tabulation shows the many types of MIDWESTERN recording oscillographs available today.



SPECS

Model	Maximum Trace Capacity (1)	Dimensions Inches (2)	Weight Pounds (3)	Record Speed Range Inches/Sec	Record Width Inches	Magazine Capacity Feet (5)	Power Requirements	Timing Lines Sec/Line	Optical Arm Inches	Temperature Range °F	Maximum Acceleration G's	Model
560	14	5¾ x 6⅝ x 7 ⅞	9	.375 To 8	3.625	50	28 Volts d.c. 3 Amps Max.	—	6.921	8 to + 160	20 (8)	560
580		7⅝ x 7⅞ x 13½	22.5	.50 To 44.75 (4)		100	28 Volts d.c. 15 Amps Max.	.01 And/Or .10	7.375	—65 to + 160	20	580
581		7⅝ x 7⅞ x 15⅝	28.5									581
544	36	11½ x 12⅞ x 20	75	1 To 50	8	200	28 Volts d.c. 10 Amps Max. or 115 Volts, 60 cps 3 Amps Max.		14.469	+ 32 to + 160	1	544
570	50	11½ x 16⅞ x 20	97		12							570
590	36	11 x 11⅝ x 21⅞	90	.882 To 129.9	7	150	(6)	(7)	11.80	—65 to + 160	15	590
591	50	11 1/16 x 16 13/16 x 24¾	130		12	250						591

FEATURES

Model	Record Numbering	Trace Identification	Automatic Record Length	Timing Line Intensity Control	Galve Lamp Intensity Control	Record Used Indicator	Recording Malfunction Indicator	Galve Lamp Burnout Indicator	Timing Lamp Burnout Indicator	Rotary Scanning	Remote Control	Model
560	—	—	—	—	√	—	—	—	—	—	—	560
580	—	√	—	√	√	√	—	√	√	—	√	580
581	√	√	√	√	√	√	√	√	√	—	√	581
544	√	√	√	(9)	√	√	√	√	(9)	√	√	544
570	√	√	√		√	√	√	√		√	√	570
590	√	√	√		√	√	√	√		√	√	590
591	√	√	√		√	√	√	√		√	√	591

NOTES
(1) Using MIDWESTERN 102 Galvanometers.
(2) Dimensions include all external controls and fittings but do not include mating electrical connectors or shock-mount base.
(3) Weight does not include shock-mount base.
(4) A low speed version of these models is available with all recording speeds reduced by a factor of 60.
(5) Listed magazine capacities are with Kodak Linagraph #809 Paper. Other standard recording paper or film may also be used. Larger capacity magazines are available for the 580, 581, 590, and 591 Models.
(6) May Le operated from 28 volts dc, 15 amps max.; or 115 volts, 60 or 400 cps single phase, 5 amps max. by means of interchangeable plug-in power supply units.
(7) Timing lines of .001 and/or .01; .01 and/or .10; or .10 and/or 1.0 seconds intervals, by means of interchangeable plug-in units.
(8) A special version of this model is available which will withstand shock accelerations in excess of 1000 gravities.
(9) Timing lines are produced by electronic flasher-tubes. Due to their much longer operating life, warning indicators are not required; and because of their flash illumination characteristic, intensity adjustments are not necessary.

for complete details on the above oscillographs — and other MIDWESTERN test recording instruments and servo components — write

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For more information circle 1 on inquiry card.

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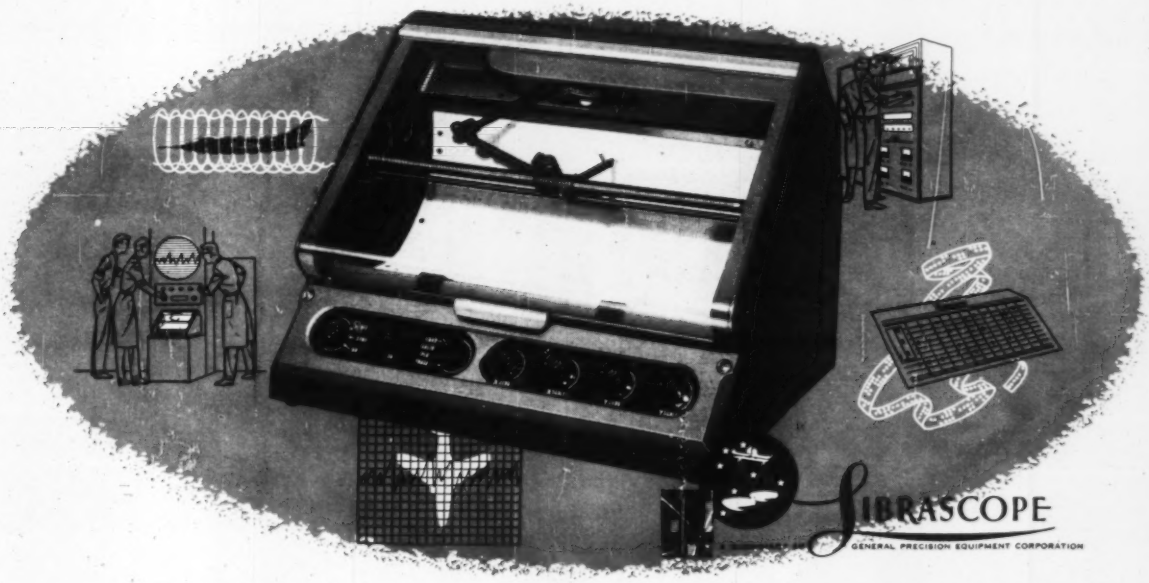

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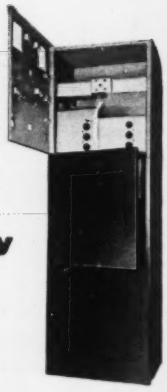

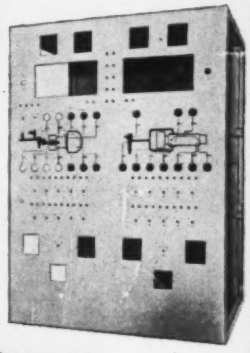

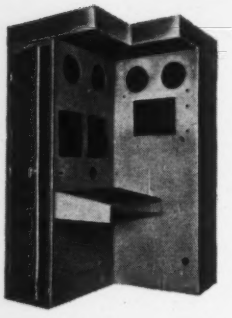

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January 1957

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

Instruments and Automation (including Instrument Manufacturing) published monthly by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 845 Ridge Avenue, Pittsburgh 12, Pennsylvania. Second Class mail authorized at Pontiac, Illinois.

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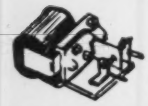

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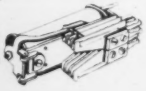

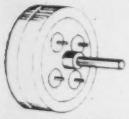

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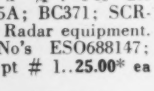

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INSTRUMENTS and AUTOMATION

Letters to the editor

Editor, I&A:

Enclosed is a copy of a talk (on "Automation—Its Technical and Social Aspects") substantially as delivered (having been typed from a magnetic tape recording of the actual delivery) with the exception that the final words of the definition of automation have been brought up to date in accordance with the revision jointly agreed to by the IRE and RETMA committees.

The use of the word "automatically" in the definition was at the insistence of the IRE committee people and was agreed to by the RETMA committee only because it was so separated from the word (automation) being defined it seemed permissible.

With regard to Mr. Falk's declaration of antithesis, it would seem that he had not read the RETMA definition comprehensively. It reads, "by utilizing elements of self-control," so that the *self-control* (which he italicizes) refers not to "human" but actually to *elements* which, by any sensible construction, would be technological.

I note with interest that in your same December issue in the editorial, you nearly paraphrase the initial words of the RETMA definition; you write, "AUTOMATION is a technique for increasing productivity." So it would seem that you have, consciously or unconsciously, adopted the form and at least some of the substance of the RETMA definition in your own writing.

I think that the more thoroughly you study the RETMA definition of automation and the more widely you try its applications, the better you will like it. And, after all is said on the subject, it stands as the only definition of automation that has anything like official recognition by an industry or professional organization.

James J. Lamb
Executive Staff Consultant
Remington Rand Univac
South Norwalk, Conn.

In this interesting talk, Mr. Lamb traces the origin of the word and discusses the RETMA definition:

"Automation is the technique of improving human productivity in the processing of materials, energy and information by utilizing, in various degrees, elements of self-control and of automatically executed product programming."

Every one of the many definitions of automation has some merit—and some measure of agreement with all others. The lengthy RETMA definition obviously meets the needs of RETMA and some IRE groups. But should each group create its own definition without regard to either other groups or the lay public? Should not the technical fraternity seek for a definition acceptable both to engineers and laymen?

Editor, I&A:

One page 2139, November *I&A*, we noted your philosophy that automation is a contraction of the words automatic operation. Without making a literature search, we had in our minds the connotation that it was from automatically made action and/or from automatic machinery action.

To define automation for a recent plant-level supervisor's conference presentation, we divided the word into auto/ma/tion and developed the language roots as follows:

auto-, from the Greek combining form meaning self.

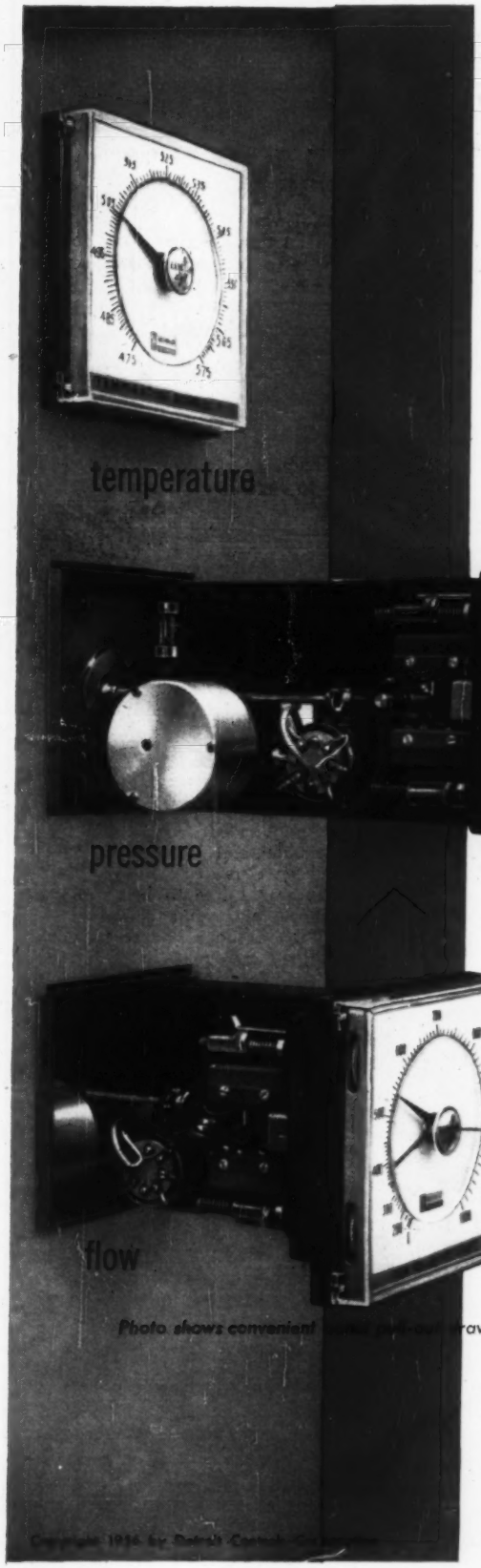
-ma-, (1) from the Anglo-Saxon verb *macion* meaning made.
(2) from the Medieval Latin verb *macio* meaning to make with bricks.
(3) from the Latin noun *machina* meaning a device.

-tion, from the Latin suffix denoting action.

From this development we obtained the binary view that automation means "self-made-action" and "a self-acting-machine". Which for us is not inconsistent.

L. G. Lawrence
Supervisor Laboratory
American Car and Foundry Division
of ACF Industries Incorporated
St. Charles, Mo.

This definition is more than consistent—it is simple, generic, and genetically logical.



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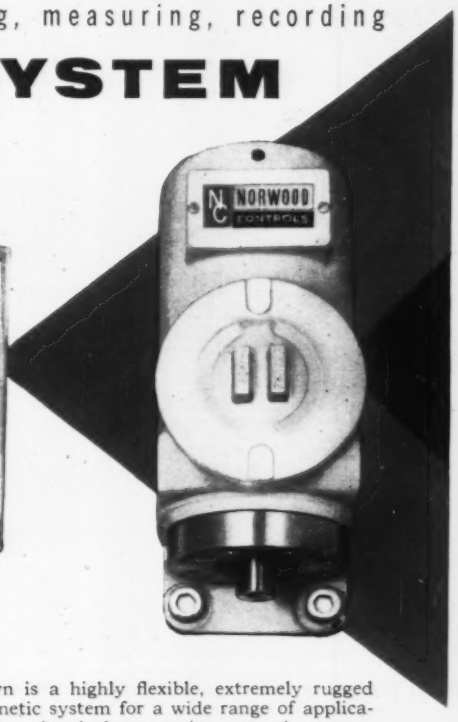

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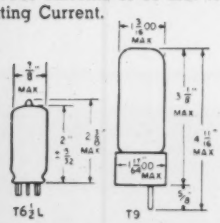

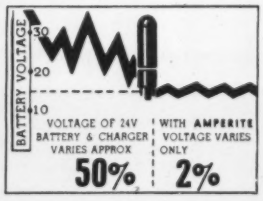

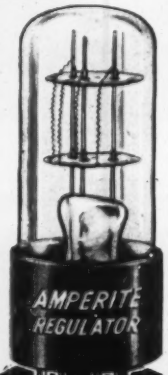

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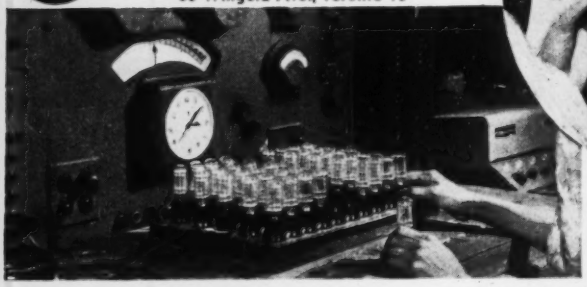

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LETTERS —CONTINUED

Editor, I&A:

The invention of automation devices appears to be our effort to transfer a manual and mental burden from our biological anatomies upon good and faithful servants of the industrial world.

To do this, it is essential to provide an order, power and sensing apparatus.

With this viewpoint, automation may be defined as a *programed process of utilizing energy and controlled, or regulated, by feedback information.*

Always responsive to the desires of men, it will produce as directed and if quantities of wealth exceed capacities to consume, we simply take another day off. The benefit accrues to leisure and culture.

Fred Wm. Molitor
Elec. Engr.
Sepulveda, California

We hope so!

Editor, I&A:

Under the heading "Table 7—Quick Reference Data on Resistance Elements" in the 1957 issue of the *Instruments and Automation Handbook and Buyers Guide,* you quote "not announced" as the low range for commercial instruments using a Tungsten element.

We would like to bring to your attention, and the attention of your readers (we include ourselves as very satisfied members of that group) that this company has been manufacturing temperature transducers with a bare wire tungsten element for many months prior to this issue.

Our transducers are manufactured for any desired range between the limits −450°F (−268°C) and 2000°F (1093°C), and may be used in either flow or static applications.

By using bare wire elements, high recovery factors and very low response times are obtained.

We trust you will find room to include this under your Editorial heading, and thus counter the comments we have received.

W. MacPherson
Pres. & Gen. Mgr.
Astra Technical Instrument Corp.
S. Pasadena, Calif.

Editor, I&A:

Would you please advise me just as soon as possible on the cost of 5,000 additional reprints of our G-15 article published in the September

Instruments and Automation? The demand for these reprints has far exceeded my expectations, and I therefore need additional copies just as soon as possible.

The inquiries from our ad in the September issue have been coming in in great quantities. . . . We are greatly appreciative of the service which you render to both us and those interested in computers by publishing these articles.

William J. McGuckin
Advertising Manager
Bendix Computer Div.
Los Angeles, Calif.

Truly powerful articles, such as the G-15 article, require reprints in the tens of thousands.

Editor, I&A:

One of our project engineers is conducting an Engineering Seminar aimed at providing a brief historical survey on instruments and instrumentation.

I have been asked to assist him in gathering material on this historical survey . . . For this historical survey on instruments and instrumentation, we would like to cover ancient Egyptian civilization, chronologically through modern times, illustrating the impact instruments have on man's progress.

Thank you for any assistance you may be able to offer us on this project.

Clifford L. Tierney
Librarian
Whirlpool-Seeger Corporation
300 Broad Street
St. Joseph, Michigan

Editor, I&A:

Enclosed you will find a list of five new subscribers for *Instrumentation and Automation*, and a check.

For the past five years that I have been a subscriber I have tried to be instrumental in introducing the magazine to the men with whom I work. At present I would say we now have ten or twelve subscribers. I'm working on the second new grouping of five and hope to have the necessary five shortly.

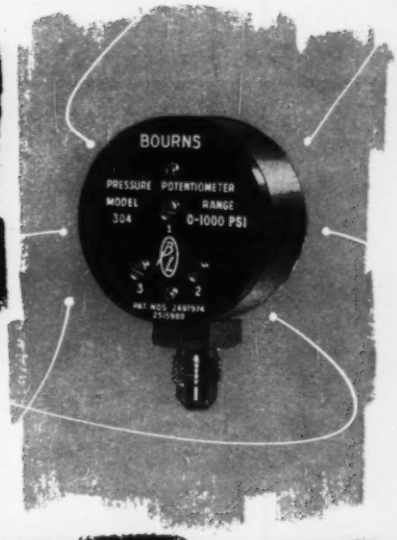
I consider it a privilege to introduce such a wonderful magazine to these men.

Harry Meyer
Asst. Foreman Turbine Lab.
Fairchild Engine and Airplane Corp.
Deer Park, L. I., N. Y.

We are privileged to have such readers.

BOURNS

MODEL 304



GAGE PRESSURE TRANSDUCER

—high performance in miniature size

Only 1⅝" in diameter . . . ¾" thick, this is an exceptionally small gage pressure potentiometer. Its miniature size and compact configuration permits use in ground and airborne installations—in control telemetering or remote recording circuits—wherever space is at a premium.

Time proved performance. This is a fully integrated instrument built for high reliability under extreme environmental conditions. The dependable Bourns Bourdon tube assembly and linkage system provide exceptional shock, vibration and acceleration characteristics . . . linearity and hysteresis are excellent. Units are designed to meet or exceed most government specifications for airborne equipment.

The Bourns Model 304 weighs about 2 ounces. It operates with a high-level AC or DC signal. Pressure ranges: from 0-100 to 0-5000 psi. Three Bourdon tube materials are available:

Beryllium copper—the standard construction—for non-corrosive fluids. Measures air, Freon, oil, and other common media.

Stainless steel—permits corrosive fluids such as fuming nitric acid to be applied within the tube.

Ni-Span-C—provides low temperature error for versatility of application.

Complete data in Bulletin No. 304.

ABSOLUTE AND DIFFERENTIAL PRESSURE

In addition to the Model 304, Bourns manufactures a complete line of high pressure transducers in absolute and differential ranges, for use with corrosive or non-corrosive fluids. Request Bulletin No. 70456.

MODEL 704—differential pressure type with stainless steel Bourdon tube

MODEL 706—differential pressure type with Beryllium copper Bourdon tube

MODEL 705—absolute pressure type for use with clean, non-corrosive media

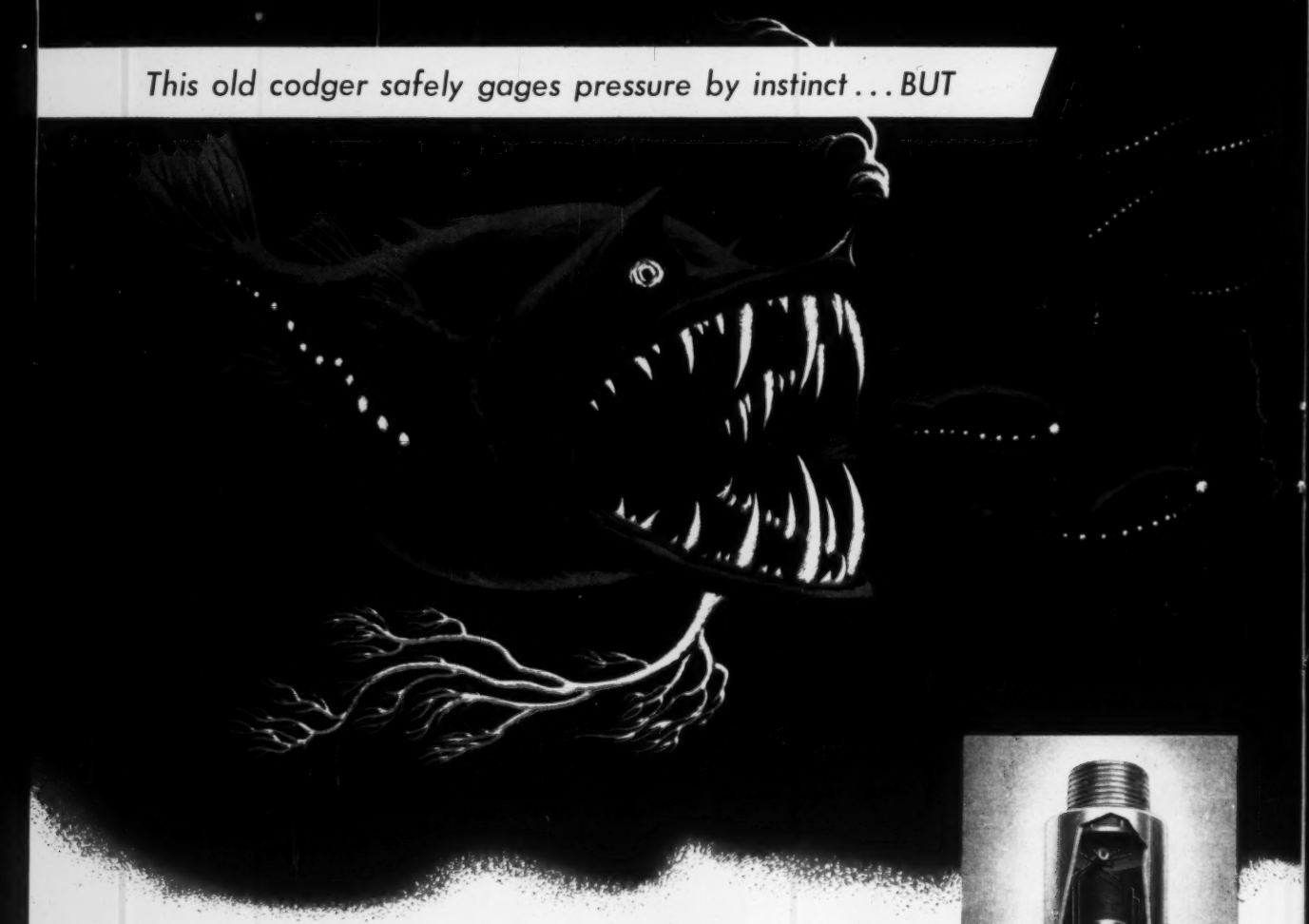
COPR. BL

BOURNS LABORATORIES

General Offices: 6135 Magnolia Avenue Riverside, California
Plants: Riverside, California—Ames, Iowa

For more information circle **8** on inquiry card.

This old codger safely gages pressure by instinct . . . BUT

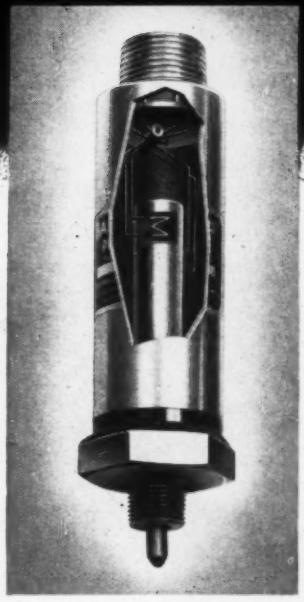


You can rely on SR-4® Pressure Cells to measure and control all industrial pressures safely to within ±¼% accuracy

The life of this toothy specimen depends on his staying at extreme ocean depths under many tons of pressure. If he ventures up too high—blooey! Suddenly diminished pressure causes him to literally explode.

B-L-H Fluid Pressure Cells are *the one way* to measure absolute or differential pressures with consistent accuracy to within ±¼%. They convert pressure changes directly into electrical changes —no moving parts to wear out, no long pressure lines with possible leakage and fire hazards. The signal can be fed to Baldwin indicators, recorders, controllers or data processing instruments—for our fishy friend, it could even activate a servomotor that would angle his fins downward and take him out of danger.

Whatever your pressure measurement problem, a B-L-H representative will be happy to help you, from selecting the proper transducer to engineering a complete pressure measuring system. Remember, a system is only as accurate as the transducer. Write today for your free copy of Bulletin 4306 on rugged, compact, reliable SR-4 Fluid Pressure Cells.



SR-4 Fluid Pressure Cells, using SR-4 Bonded Wire Strain Gages, are rugged, dependable and convenient. Typical cells show no loss of accuracy after 1,000,000 cycles of pressure at 100% of capacity. A wide range of SR-4 Pressure Cells is available for any industrial application.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle 9 on inquiry card.

BALDWIN · BLH · LIMA-HAMILTON

Heiland Instruments' Insert is referred to as 10 on inquiry card.

The most important announcement
in modern oscillograph history...
the dramatic new Honeywell direct-recording
VISICORDER®
All at once you can record and read the record of the Visicorder. Using a completely new direct-recording principle, the Visicorder puts six channels on a direct-reading record at sensitivities comparable to photographic oscillographs, and at frequencies from DC to 2000 cps!
VISICORDER
H
HONEYWELL

HONEYWELL

THE **NEW** *VISICORDER,* perfected after years of research by the Heiland Division of Honeywell, combines the high frequency and high sensitivity characteristics of photographic oscillographs with the convenience of a direct-recording instrument.

By means of a completely new type of recording paper, light source, and optical system, the Visicorder makes use of mirror-type galvanometers to record phenomena from DC through 2000 cps *without* peaked amplifiers or other external compensation.

The record requires no liquids, vapors, powder magazines, or other processing materials. Development is accomplished by external light only as the record emerges from the oscillograph.

The Visicorder records are stable and require no further processing under normal conditions. They may be subjected to room light for extended periods without fading, and are permanent indefinitely when protected from light. Should it be necessary to subject the records to direct sunlight, they may be chemically "fixed" (in room light) using conventional photographic practices.

Visicorder records are reproducible by several methods using commercially available equipment.

Since the Visicorder operates on light-beam galvanometers, traces may deflect the full 6" width of the chart, peak to peak, and their deflection is not limited by adjacent channels.

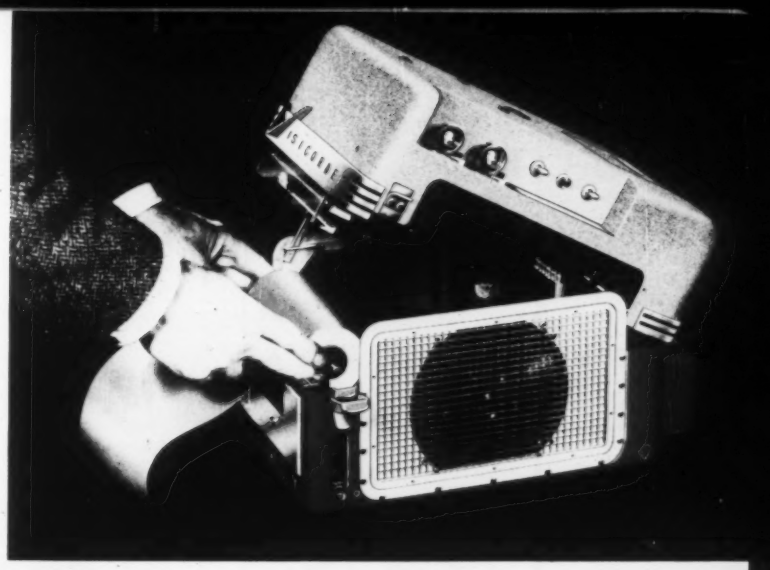
The remarkable exclusive features of the Visicorder make it the ideal recording oscillograph for applications where readable, permanent analog records are required and for additional uses where the measured phenomena need to be monitored or where immediate recorded results are desirable.

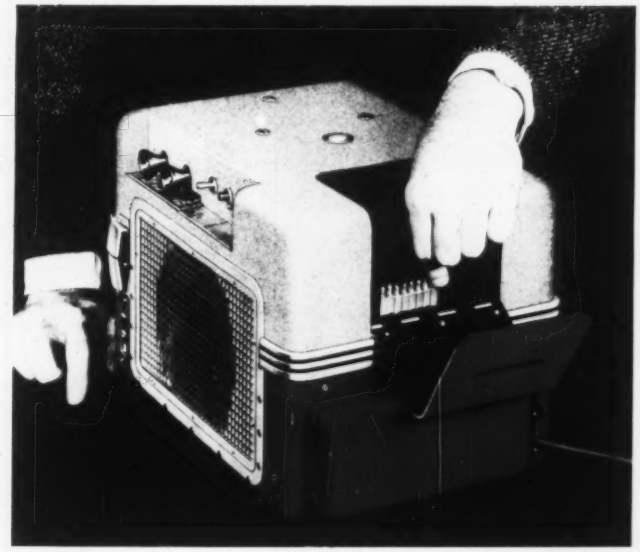
GENERAL FEATURES

FREQUENCIES	From DC to 2000 cps without peaked amplifiers or other compensation of any kind.
SENSITIVITIES	Comparable to photographic-type oscillographs.
RECORDING METHODS	Records directly on paper which requires no powder magazines, liquids, vapors, or other processing. Records are immediately visible and usable. Daylight loading. Accommodates recording paper 100 feet in length. Indicator shows unused recording paper available.
NO. OF CHANNELS	6 channels on 6" wide paper plus provisions for two timing traces.
DEFLECTION	Full 6" peak to peak. Traces may overlap; not limited by adjacent channels.
RECORD SPEEDS	0.2, 1, 5, and 25 inches per second, minute, or hour.
GALVANOMETERS	D'Arsonval-movement mirror galvanometers with choice of natural frequencies to suit individual requirements.
AMPLIFICATION	None required for most applications.
POWER	115 volt 60 cycle AC operation. 4 amperes.
DIMENSIONS	10" height; 15" depth; 10" width.
WEIGHT	37 pounds, complete and ready to operate.
PRICE	$2,500.00, less galvanometers. Galvanometers $150.00 each.

Deliveries starting January, 1957

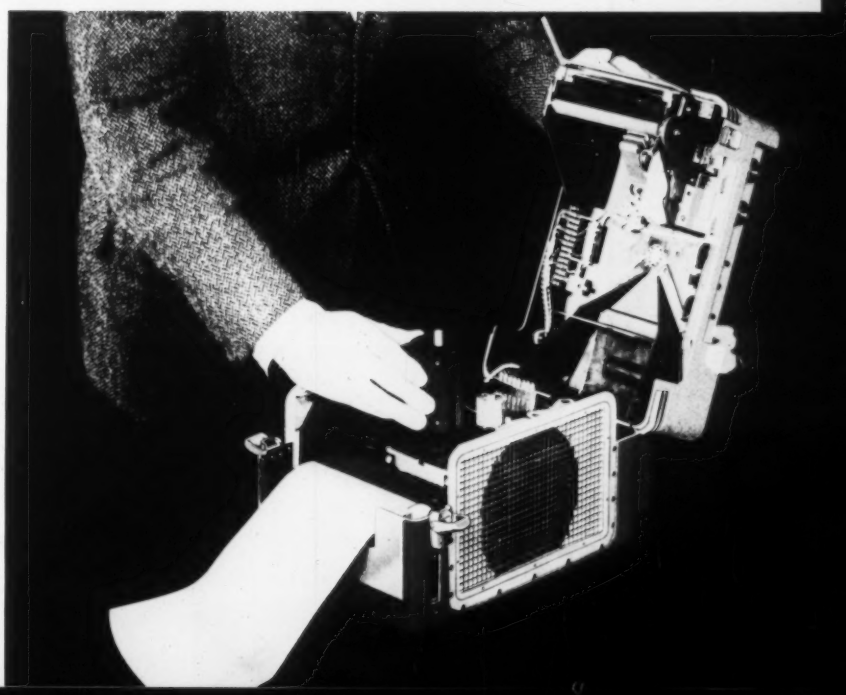
❶ *THE VISICORDER* is the first and only photographic-type oscillograph that can be loaded with recording paper in daylight. The paper speeds can be selected while the instrument is in operation. The light spots from the galvanometers are *visible from the exterior* at their point of contact with the paper; thus phenomena can be monitored simultaneously with their recording.





❷ *GALVANOMETER ADJUSTMENTS* may be made through a panel-covered opening in the back of the instrument. Other operating controls —power on-off, lamp switch, paper drive and paper speed—are located on one convenient panel. Galvanometers are of the familiar Heiland solid-frame type: high sensitivity, accurate balance, high stability, low drift, in a versatile range of frequencies and sensitivities.

❸ *SERVICE* on the Visicorder is extremely easy, since the instrument opens completely as shown. All components—galvanometers, recording lamp, transmission—are completely accessible.



VISICORDER® APPLICATIONS

The versatile Visicorder will fit almost unlimited applications because of its high frequency and sensitivity characteristics, and because of its ease of operation.

In any application where instantaneous monitoring is needed, whether or not a record is desired, the Visicorder is ideal.

★ **In CONTROL** applications the Visicorder will continually monitor and record reference and error signals, and present an immediately available recording of information.

★ **In NUCLEAR** applications, the Visicorder will monitor and record temperatures, pressures, and all other phenomena needed.

★ **In PRODUCTION TEST** applications, the Visicorder will provide a final dynamic inspection of electrical and mechanical devices such as motors, relays, generators, governors, solenoid valves, etc., where high frequency response has been required, but unavailable in the past.

★ **In COMPUTING** applications, the Visicorder will provide immediately-readable analog recordings representing dynamic solutions at much higher frequencies than have ever been available via pen—and-ink-type recorders previously used for this work.

★ **In PILOT and COMPONENT TESTING,** the Visicorder will accomplish more rapid evaluation of design and prototypes than any other direct-writing oscillograph available.

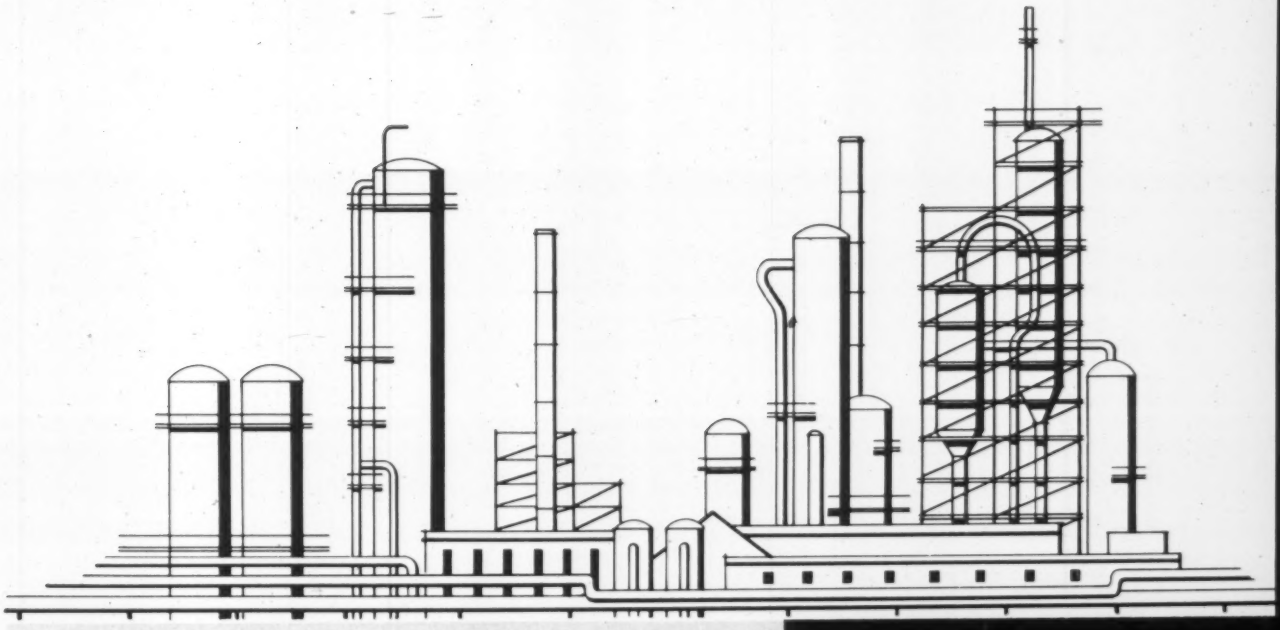
★ **In MEDICAL** applications the Visicorder is useful for dynamic blood pressures, electrocardiograms, EEG, and other physiological measurements.

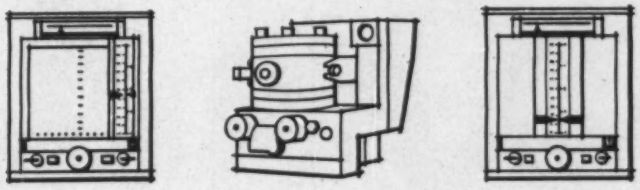
★ **In all TEST** applications the direct-recording features of the Visicorder are invaluable. Where complex tests involve the assembly of considerable equipment and the gathering of personnel, the immediate Visicorder record will prove the success of the test at once before the test equipment is dispersed.

For further information about the Visicorder, contact the Minneapolis-Honeywell Industrial Division Sales Office nearest you. Sales-service facilities in over 130 principal cities throughout the world.

700-C Series Recording Oscillographs
Galvanometers
Bridge Balance Units
Amplifier Systems
HEILAND Photo-Flash Equipment

MINNEAPOLIS
Honeywell
HEILAND INSTRUMENTS
5200 E. EVANS AVENUE • DENVER 22, COLORADO





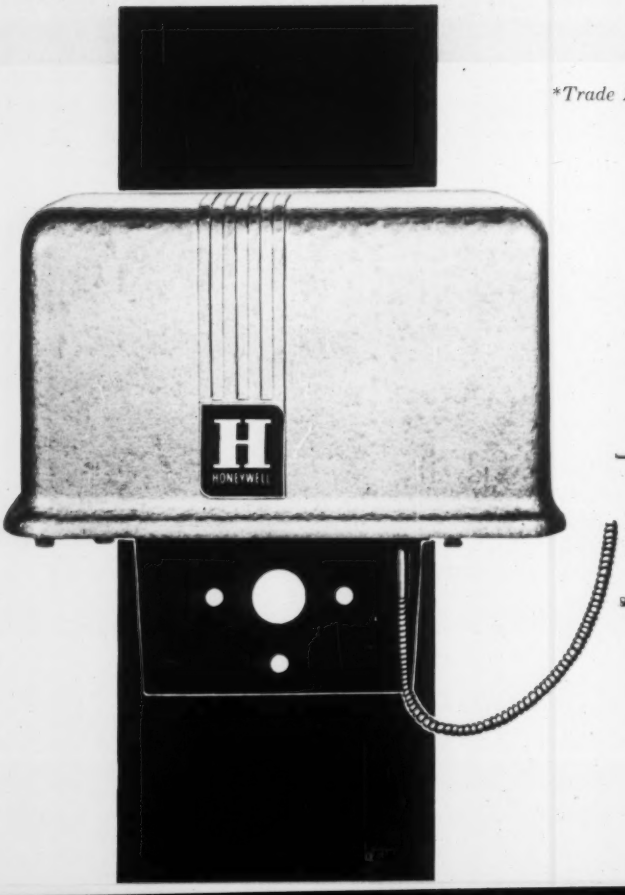
today's most advanced transmitter

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

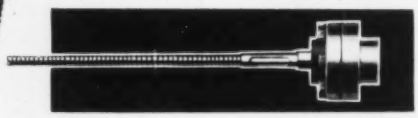
only the
TEL-O-SET
transmitter

gives you full rangeability without changing parts

**Trade Mark, Minneapolis-Honeywell Regulator Co.*

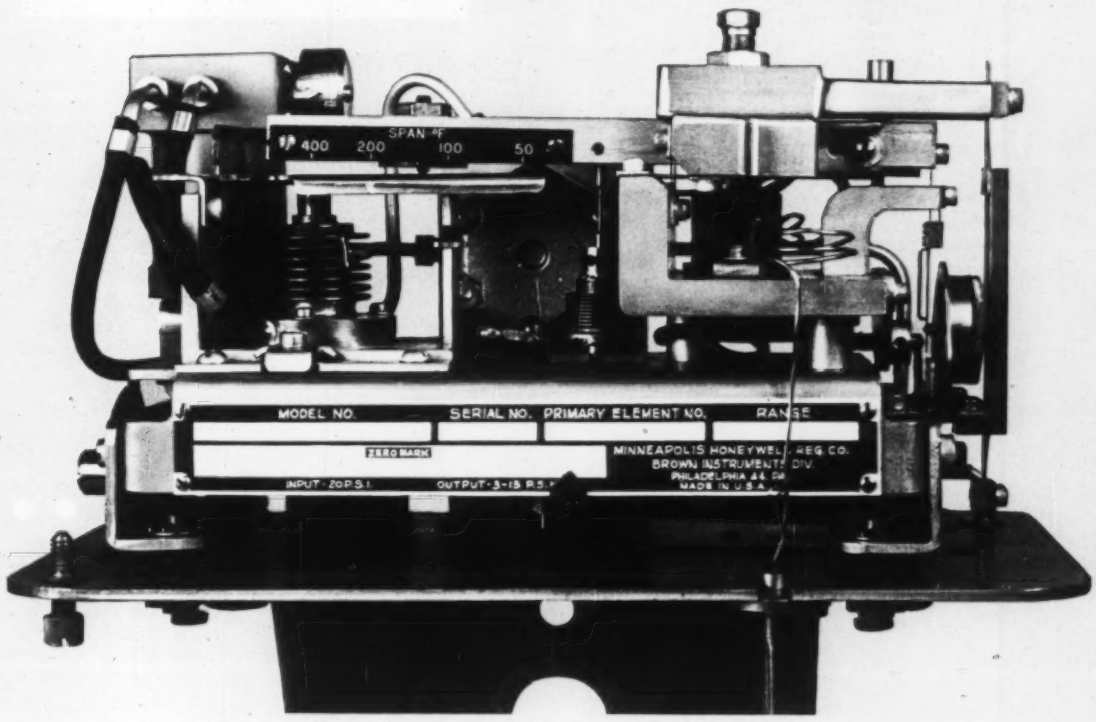


Temperature sensing element **has small size bulb for fast response. Either plain or coiled bulbs are standard, with or without union connections. For food processing applications, bulb is available with union connection for Type 3A4 sanitary fitting.**



Pressure sensing element **—a sealed volumetric pressure unit with stainless steel diaphragm and flange protects the transmitter from corrosive material, and damps line pulsations.**

Accessibility of all parts is shown in this interior view of the transmitter. Span and zero adjustments are easy to make, with no change of parts.



THE *Tel-O-Set* transmitter offers complete versatility. This highly accurate pneumatic force-balance instrument measures temperature, gage pressure or absolute pressure, and transmits a proportionate output signal to a receiver or controller. It requires only one thermal system and one pressure system for all ranges, and changeover from temperature to pressure measurement is extremely simple.

You can adjust the span to any values between 20 and 150 psi, or 50 F and 400 F. And you can shift the span to cover any part of the overall transmitter range . . . from 40 to 600 psi, or from —375 to 1000 F . . . *without changing parts.*

The *Tel-O-Set* transmitter is unmatched in performance. It's just as accurate at small spans of 20 psi and 50 F as at wide spans of 150 psi and 400 F. It responds swiftly to changes in temperature or pressure to give you control within close tolerances. It's effectively compensated for ambient temperature and pressure, and fully protected against the effects of vibration.

While offering the best in transmitter performance, the multi-purpose *Tel-O-Set* transmitter saves you the expense of stocking an assortment of thermal and pressure systems or spring assemblies . . . and simplifies the training of your operators and maintenance men.

Get complete details on *Tel-O-Set* transmitters . . . and related *Tel-O-Set* miniature indicators, recorders and controllers . . . from your nearby Honeywell sales engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

• **REFERENCE DATA: Write for Specification S1003-1.**

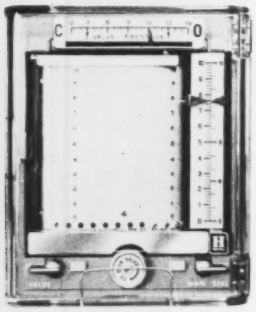
H HONEYWELL

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

TEAM THE TEL-O-SET TRANSMITTER WITH...

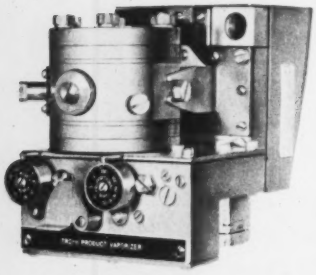


TEL-O-SET INDICATORS AND RECORDERS

. . . for simplest installation, startup, service

These precise, instantly-responding instruments work with any pneumatic force-balance controller . . . are applicable to temperature, flow, liquid level. They'll save you time, trouble and money, from the instant you install them on your control panels.

- ***Easy installation*—Indicating and recording chassis can be supplied separate from the case, for installation after piping connections are made.**
- ***Foolproof startup*—You can check the air lines, stroke control valves, and make final inspection *before* chassis and controller are installed.**
- ***Serviced in seconds*—To adjust zero and span, or inspect parts, you can partly withdraw the chassis from the case without interrupting operation.**

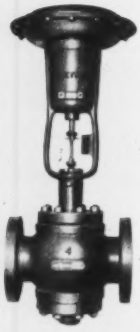


TEL-O-SET CONTROLLER

. . . one model controls any process variable

The adjustable band *Tel-O-Set* controller gives you swift, sensitive control of any process variable. If necessary, you can replace one *Tel-O-Set* controller with another in a few seconds. Downtime is minimized. Maintenance is simplified. Your spare parts inventory is reduced. And you can easily change processing techniques without buying additional instruments.

- ***Three reset ranges* to tune control action to suit any process.**
- ***Compensated rate action* is easily added to the basic model to minimize overshoot.**
- ***Unitized construction* permits easy replacement of all major components.**
- ***Quick-Connect mounting* simplifies installation and servicing.**



THE NEWEST HONEYWELL SERIES 800 DIAPHRAGM CONTROL VALVE

Here's a notable advance in pneumatic valve design. Top-quality Series 800 valves give you the sensitivity, fast response and accurate reproducibility you need for critical applications. Maintenance is minimized.

- ***Pressed steel diaphragm case* treated to resist corrosion.**
- ***Rigid cast iron yoke* protects stem alignment.**
- ***Bolted packing gland* assures easy adjustment, maximum safety.**
- ***Interchangeable 3-15 and 6-30 psi springs.***
- ***Top and bottom guiding* for positive control action.**
- ***Oilite guide on actuator stem* reduces friction.**

Available in a wide variety of body types, sizes, materials, actuators, and auxiliary equipment. For complete details, write to:
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Valve Division*, Phila. 23, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario

The Instrument Salesman

Panhandle Pete

Blue Monday, December 1956. Got up early, put one of my prize fifths of West Virginia whiskey in the ice box; called plumber to come hook up my new electric water heater and remove the old coal-fired furnace and install my new "Sunshine" gas furnace; made arrangement with wife to cook up one of my prize ducks for dinner; called electrician to come hook up the water heater. Boss not in the office for all week, but went in to work anyhow. I feel lucky to-day.

Got a call from the factory. Sales-manager started in on my last quarter's sales quota—showed him where I had sold more than anyone else in the office, including the Boss. It isn't my fault if the customers cancel the orders just as the stuff is loaded at the factory, is it?

Customer called on phone and wanted quotation on box of charts. Before he could get away I sold him 500 boxes of charts—special group offering—thirty gallons of assorted colored inks, ten instruments with on-off control, thirty instruments with dynamic disapators, thirteen instruments with our new hush-hush control system known as Parallel Parametric Parameter (this is so new our sales force hasn't heard about it yet) and persuaded the customer that since his troubles were our troubles why didn't he consider our guaranteed monthly maintenance program for only $510.30 per month and not have any troubles? Wow! Wait till I tell the Boss! I always said one has to know all about instruments and controls before he can sell.

Had luncheon date with "Horse" McNulty at the Penn-Sheraton. "Horse" called at 11:55. "Have to leave town. Do you mind taking my wife and daughters to lunch? I wasn't going to buy anything anyhow." Hmmmm! Do I mind taking "Horse's" old woman and younguns to lunch? Holy smokes! And he wasn't going to buy anything. . . . . Sneaked in the back door to look over the situation. Wonder who that good-looking dame is with the two blondes? Oh no! Yes! Slipped out the side door, purchased roses, handkerchiefs, candy; returned, met the beauties, had a most enjoyable lunch and laid it on thick.

Mrs. "H" most impressed. Said I reminded her of her late father. Wanted to know what she could have "Horse" buy to "make up for your generosity." Taking a wild guess I told her we had a new encoder I thought "Horse" could use. This consisted of a zipper stabilized phase modulated amplifier with side to side biased heptodes as the feedback. Each bit is bi-laterally closed by the permastatic gate and the digital circuitry, consisting of a 13 stage circle counter, a 113 stage code digester, heptode gates, a hit-run, over-under dynamic pulsifier and cathode follower is all supplied information from not one, but two memory tanks. This is an off-the-shelf item and sells for only $314,159.13. And, I added, this is just about what "Horse" needs. So I wrote up the order for Mrs. "H" and she said she'd make "Horse" sign it just as soon as he came home. Boy, oh boy, oh boy! Wait till the salesmanager sees this! Wait till "Horse" finds out he is buying something afterall! If there is anything I know all about, it is instruments!

Went back to the office to check out and had call from wife. "Bring home loaf of bread, shoestrings, piece of glass 8″ x 10″, and hurry dear, because the water heater doesn't work and there is something wrong with the furnace—the house is cold." Went back to the Service Department and borrowed their "Little Rebel" Circuit Tester. Got home and mixed highball before checking anything. Took thermostats apart on water heater. Cleaned points, checked fuses, throwed mainswitch with "Little Rebel" on 'Ohms.' Big flash and cloud of smoke. Oh well, can always buy another one with profits from "Horse's" order. Couldn't find anything wrong so finally stuck jumpers across the thermostats.

Started on furnace. Mixed another highball with less "high" in it. Turned on lights and went down to basement. Furnace firing like mad and gas meter spinning like pinwheel. Hollered at wife. "Yes dear, house is getting warm. Thanks." Came upstairs, turned off lights, sat down to read paper. Still cold, better mix another drink. Wife put on coat. Went back down stairs . . . furnace firing like mad . . . house getting warm again . . . went back to finish reading paper . . . poured another drink . . . feel pretty warm now . . . wife went to bed . . . said I could eat my duck in the cold house if I wanted to. Went to bathroom to wash up for supper . . . My gawd, there's steam coming out of the hot water tap! Got wife out of bed to show her. . . ."But dear, I *felt* the new water heater and it was cold. The old one always felt hot when the water was hot." Holy smokes! How stupid can people get? Filled up another glass to steady my nerves.

Went down basement to study the situation. If anybody can figure this thing out it is me because I do know instruments and controls, if I do say so myself. Furnace still firing like mad and gas meter whizzing along. Shut down furnace, took controls all apart, cleaned gas solenoid, thermostat, bonnet control, gas regulater. Emptied the bottle. Reassembled everything, turned furnace back on and watched it fire like mad again. Well! That's that! House damned cold by now and wife turned out light on way back to bed. Furnace quit firing! Wait a minute. "Hey, old lady! Turn on the lights. I'm still down here." Snap! Furnace firing again. . . . . .Well I'll be damned! Who connected up the furnace to the light switch? "But dear, I just told the man to plug it in right there in that light socket. How was I to know it would turn off with the basement light? Isn't it automatic?"

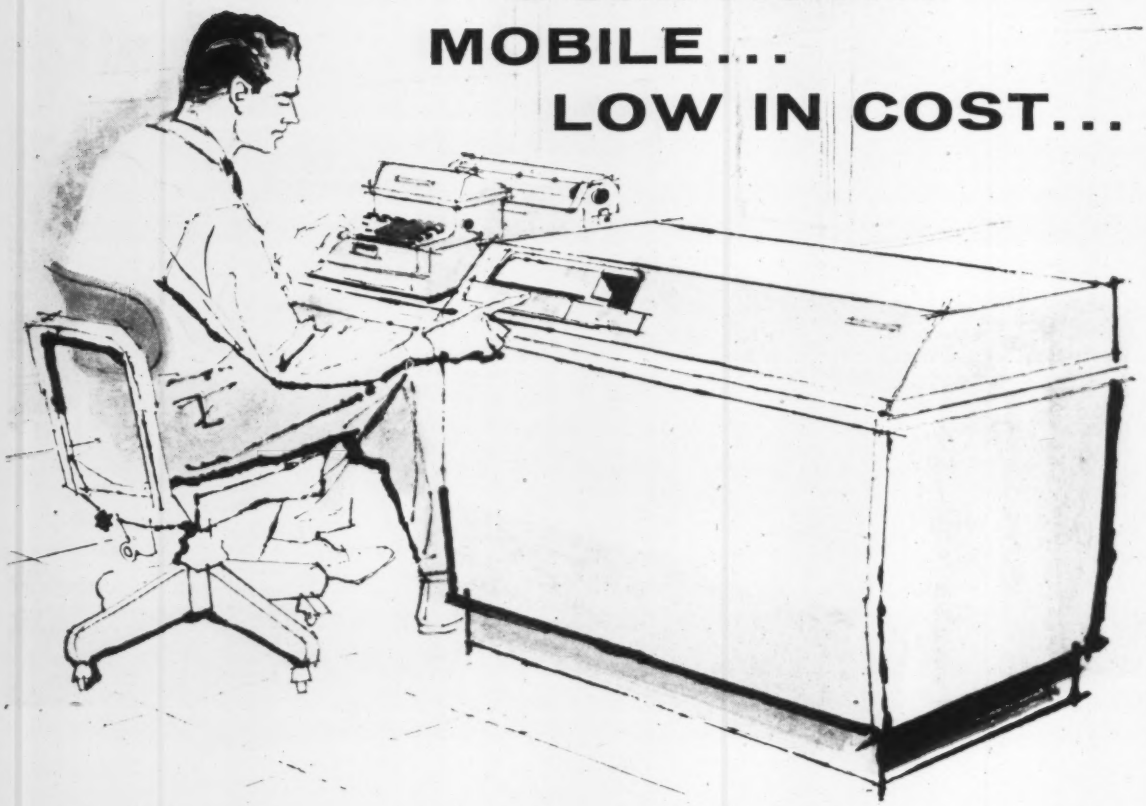
Like I always said, you have to know all about instruments and controls. . .(You also have to be able to hold a lot of whiskey.—MHA)

Panhandle Pete

(With apology to Frank Dimit, Weirton Steel Company and Bob Hankison, Hagan Corporation.)

Royal Precision LGP-30 Electronic Computer

COMPACT... MOBILE... LOW IN COST...



helps increase productivity of valuable engineers

Time-Saving. The LGP-30, a stored program computer, eliminates much detailed calculation and makes more time available for creative engineering.

Personalized. The LGP-30 brings high-speed electronic computation directly to the desk of the individual engineer. Most problems can be programmed completely right in his own office and followed through to the end — with modifications made from intermediate results as required.

Complements central computing installation. The LGP-30 can serve as a "satellite" to a central computing installation for those problems which are performed more effectively on a decentralized basis. New programming techniques permit the use of one code for both machines. Thus, programs may be prepared in the central computing facility directly from engineers' equations, and the computations done on the LGP-30.

Outstanding features of LGP-30

- Operates from regular wall outlet (110 volts AC).
- Requires no expensive installation . . . no external air-conditioning.
- Stored program computer.
- Unusually large "memory"—4096 words.
- Enters and reports numerical or alphabetical information by punched paper tape or keyboard.
- High-speed operation . . . finger-tip control.
- Lowest cost ever for a "complete" computer.
- Excellent service facilities available.
- Now being delivered.

For further information, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE
CORPORATION
GENERAL OFFICES: PORT CHESTER, N. Y.

For more information circle **12** on inquiry card.

Inquiries

These inquiries, representing problems facing readers of **Instruments & Automation**, are published as a free service to our readers.

Blendor Identification

British export house wants to identify maker of "Waring Blendor" type "Universal Cyclon" with stirring apparatus made by Oster Mfg. Co. A-182

Detector of Buried Material

Chemist in research lab wishes to contact makers of "an instrument that could be used to locate buried material." A-183

Sealing of Cellophane Bags

Hosiery manufacturer seeks machine that can fold flap of cellophane envelopes (containing nylon hosiery), seal, and automatically stack them. A-184

Low-range Pressure Gage

Manufacturer of surgical device needs meter to indicate force required to open tiny relief valve, in the pressure range of 5 to 50 mm WC. A-185

Safety Valve

Director of medical instrumentation development company is looking for a small safety valve for air "that will open at around 6 psi and remain open until mechanically reset." A-186

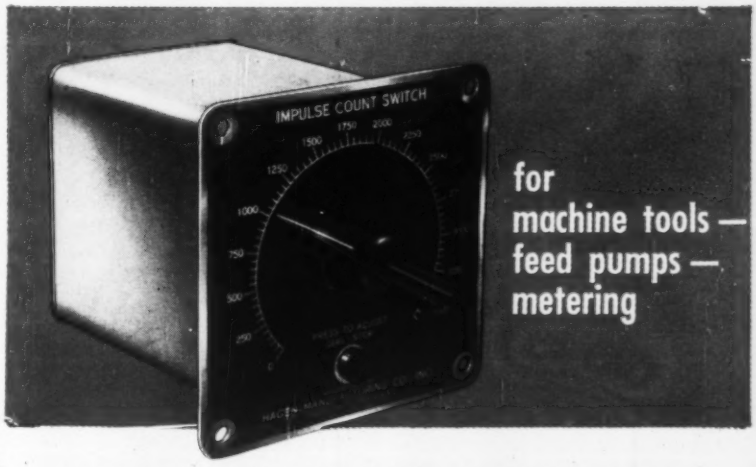
Gravimetric Flowmeter

Engineer in aircraft research division is seeking air (or gas) flowmeter for gravimetric measurement of air/gas rate with a flow tolerance of ± 1% from 1 to 200 scfm, at pressures from 100 to 950 psig, and ambient temperature. A-187

Recording Milliammeter or Voltmeter

Vice president of Canadian company specializing in electronic control systems for the mineral dressing

HAGEN count switch



PAID FOR BY SAVINGS MADE ON JUST TOOL

Simply set this Hagen Count Switch to the number of operations at which a tool should be changed. The count switch trips a switch after a preset number of electrical impulses . . . and thereby shuts down the machine automatically. Tool wear never reaches the point where tools must be ground down excessively to resharpen. That means increased tool life, reduced tooling costs and fewer rejects. Compare the savings on just *one* tool with the cost of this reasonably priced Hagen Count Switch. Chances are, the savings will be much greater.

This Hagen Model 70 Count Switch has 72 dial divisions . . . 72 possible settings. Dials are available with up to 54,000 counts. Accuracy: 1% of full scale range. Ideal for feed pumps and metering operations. Send coupon for Bulletin 780 — or data on the complete line of reset and repeating cycle timers and counters, interrupters and control assemblies.

MAIL COUPON TODAY!

HAGEN MANUFACTURING COMPANY, INC.
Dept. IA-157, Moline, Illinois

☐ Please send free Bulletin 780 on Hagen Count Switch.

☐ Send free data on counters, timers, interrupters and control assemblies.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

For more information circle **13** on inquiry card.

You Can't Beat a BRYANT MAGNETIC DRUM

for digital computers, inventory control systems and tape-to-card converters, also as delay lines, synchronizers and frequency generators.

- Designed to purchaser's requirements
- Guaranteed accuracy of drum runout .00010" T.I.R. or less
- Air bearings or super-precision ball bearings
- Belt drive or integral motor drive, speeds to 100,000 RPM
- Capacities to 5,000,000 or more binary digits
- Vertical or horizontal housing
- Head mounting surfaces to suit
- High density magnetic oxide or electroplated magnetic alloy coating

High Speed Motors, Spindles and Drums

Bryant designs and manufactures electromechanical components for precision operation up to 200,000 RPM, and magnetic drums from 2" diameter x 3" length to 20" diameter x 42" length. If you have a problem in applying high speed rotating equipment to your product, write Bryant today.

BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-I, Springfield, Vermont, U.S.A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

For more information circle **14** on inquiry card.

INQUIRIES —CONT.

industry is seeking inexpensive recording milliammeter with 6 to 10" circular chart (range 0-1 milliamp dc); or 1000-ohms/volt (or greater) dc voltmeter (range 0-50 or 0-75 volts). A-188

Atmometer

Administrative officer in Government public health lab is in urgent need of source of supply for atmometers (instrument for measuring the rate of evaporation). A-189

Tachometer Pickup

Senior engineer of nuclear instrumentation company is seeking zero speed tachometer pickup for use in the continuous process industries. Device must be able of producing electrical pulses proportional to input speeds from zero to 3000 rpm. No environmental hazards exist, but explosion-proofing may be required later. A-190

Binary Code Discs

Physicist in University Applied Physics Lab is seeking sources of supply for binary code discs. A-191

HASLER SPEED INDICATOR

Chronometric Tachometer with separate reset button for cumulative readings

Accurate
Automatic
Durable
Flexible
Portable
Non-magnetic

Type A	0-20,000 r.p.m. or 0- 6,000 f.p.m.	Size 2¾" x ⅞" x 4" Spindle incl.
Type B	0- 2,000 r.p.m. or 0- 600 f.p.m.	Weight 7¾ oz. ready for test

Shipment within 5 days from stock

All Sales and Service by

HASLER—TEL CO., INC.
28 Vesey Street, New York 7, N. Y.
U.S. Distributors for Hasler Speed Indicators since 1919

For more information circle **15** on inquiry card.

Events

February 4-8
26th Session of Norelco X-ray Diffraction School will be held at the plant of North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.

February 5
Meeting of the Society for Applied Spectroscopy, Hotel New Yorker, N. Y. For information write Frank M. Biffen, Johns-Manville Res. Center, Manville, N. J.

February 19
Meeting of Society for Applied Spectroscopy, Philadelphia College of Pharmacy & Science. For information write Frank M. Biffen, Johns-Manville Res. Center, Manville, N. J.

February 14-15
1957 Transistor and Solid State Circuits Conference, Univ. of Pennsylvania, Phila., Pa. Sponsored by IRE and AIEE.

February 19
13th Annual Quality Control Clinic sponsored by Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

February 25-27
Third Annual Electronics Conference of the American Management Association, Hotel Statler, New York 36, N. Y.

February 25-27
Military-Industrial Symposium on Guided Missile Electronic Test Equipment, Redstone Arsenal, Huntsville, Ala.

February 26-28
1957 Western Joint Computer Conference, Statler Hotel, Los Angeles, Calif.

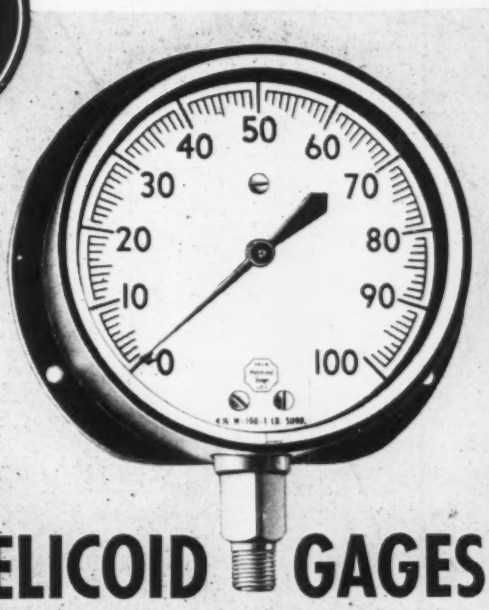
March 4-8
Eighth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Penn-Sheraton Hotel, Pittsburgh, Pa.

March 5-8
1957 Conference on High-Speed Computers, Louisiana State University, Baton Rouge, La. For information write Frank T. Carroll, Jr., College of Engineering.

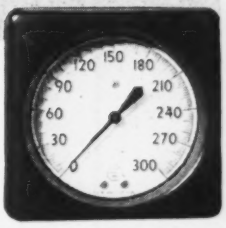
March 11-14
The IRE Professional Group on Nuclear Science is cooperating with the

an ACCO product

Helicoid Gages



How HELICOID GAGES can save YOU money!



Acaloy square flush case

LONG LIFE:

HELICOID Gages are pressure instruments of extreme precision and long, trouble-free service with minimum maintenance. Have no gear teeth to wear out.

SUSTAINED ACCURACY:

HELICOID Gages have many unique and exclusive features which result in the highest degree of gage accuracy. Tubes, for instance, will withstand hundreds of thousands of pressure pulsations and will not stretch, leak or crack.

JOB-DESIGNED:

HELICOID Bourdon tubes are made from seamless tubing of alloy steel, K Monel, stainless steel or phosphor bronze. Each is designed to give best service under specific conditions. Available in complete line of cases for wall or stem mounting.

Helicoid Chemical gage

Send for catalog

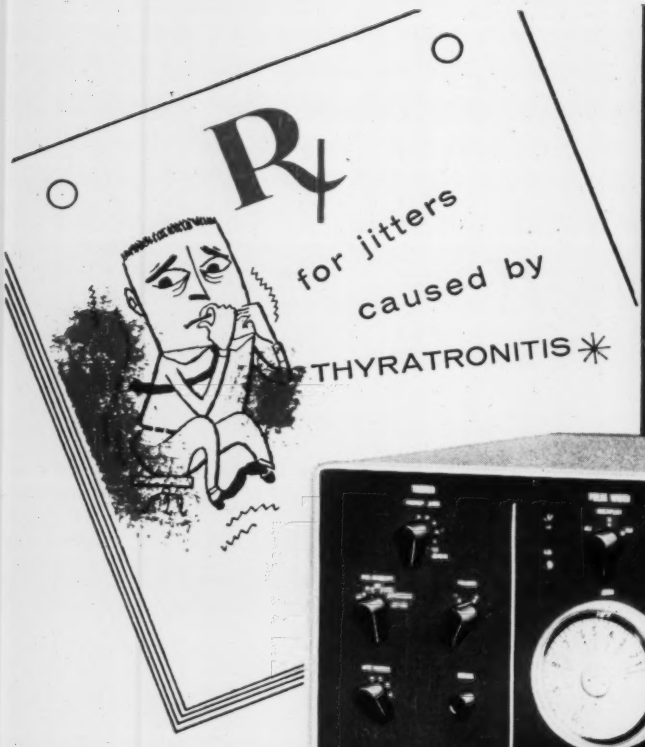
ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-B Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

For more information circle **16** on inquiry card.



one of the 400 series

Hard Tube Circuitry: Hard tube circuits assure jitter-free relationship between pulse and synchronizing triggers.

Repetition Rate: 100,000 PPS to single pulse with either positive or negative polarity.

DU MONT 404 PULSE GENERATOR

✳ *DEFINITION:* A common ailment of an hereditary nature, common to certain species of pulse generators. **Symptoms:** bumps, squiggles, and twitches in pulse. **Cause:** nervous triggering of pulse due to too much hydrogen in thyratron (or something like that).

PRESCRIPTION: Hard tube circuitry for pulse generation.

Du Mont's done it! Here is a pulse generator that you can depend on for high-speed pulses that are clean and accurate **every time.** A completely new hard-tube circuit provides pulses with a broad range of widths, amplitudes and repetition rates, resulting in an instrument that can simulate virtually any test condition.

There is no other pulse generator that approaches the 404 in performance, operating ease, or value. Write for complete details...

SPECIFICATIONS

Pulse Output: Nominally 50 volts across 50 ohms. Attenuator provides up to 60 db attenuation in 10 db increments. Attenuator accuracy, ±3%. Overshoot less than 3%, positive or negative pulse polarity.

Pulse Duration: Variable from 0.05 usec to 100 usec continuously variable; rise or fall time less than 0.015 usec; duty cycle, 10%. Automatic, built-in overload protection.

Repetition Rate: Internal, external or manual. Internal 10 pps to 100,000 pps, continuously variable. Facilities for external trigger up to 100 kc. Manual push button for single pulse operation.

Trigger Output: 25 volts across 50 ohms, positive or negative. Rise time less than 0.05 usec; width, 0.1 usec.

Pulse Delay: −2 to +8 usec with respect to internal or manual trigger, continuously variable.

$427.50* *Slightly higher for 50 cycle areas.

Cat. No. 4013-A Operation 115-V, 50/60 cps

DU MONT®

TECHNICAL SALES DEPARTMENT ALLEN B. DU MONT LABORATORIES, INC., CLIFTON, N. J.

For more information circle **17** on inquiry card.

EVENTS—CONTINUED

EJC Second Annual Nuclear Science and Engineering Congress in Philadelphia. For information write Dr. Sidney Krasik, Editor, IRE—PGNS Transactions, 5621 Wilkins Ave., Pittsburgh 17, Pa.

March 18-21

Institute of Radio Engineers National Convention and Radio Engineering Show, Waldorf-Astoria Hotel and the New York Coliseum. For more information write IRE, 1 E. 79th St., N. Y. 21, N. Y.

March 18-21

First Military Automation Exposition, New York Trade Show Bldg., 500 8th Ave., New York City, N. Y. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Penna.

March 19-21

151st National Meeting American Meteorological Society, Univ. of Chicago. For information write Louis J. Battan, Univ. of Chicago, Chicago 37, Ill.

April 8-11

14th Annual British Radio and Electronic Component Show, Grosvenor House and Park Lane House, Park Lane, London, W. 1. For information write Andrew Reid, Radio Industry Council, 17 Fleet St., London, EC4, England.

April 10-12

First National Nuclear Instrumentation Conference, Atlanta, Georgia, sponsored by ISA. For information write Herbert S. Kindler, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

April 11-13

Ninth Southwestern I.R.E. Conference and Electronics Show, Shamrock Hotel, Houston, Texas.

April 22-24

IRD's 3rd Annual Conference on Control System Applications, Northwestern Univ., Evanston, Ill.

May 1-3

Electronic Components Symposium, Morrison Hotel, Chicago, Ill. For information write J. S. Powers, Electronic Components Symposium, 84 E. Randolph St., Chicago 1, Ill.

May 9-10

1957 Annual Meeting of the Professional Group on Microwave Theory and Technique, Western Union Auditorium, New York, N. Y.

EAGLE

time delay relay

for transmitters and other industrial or aircraft applications

Compactness . . . plus **"Mil-Spec"** precision

A complete timer, weighs only 9 ounces. Yet it passes rigid military tests for accuracy, vibration, shock, salt spray, humidity. Developed for radio and radar transmitters, now available for any application that requires this precision, space-saving timer.

As one example, this new timer (HYS series) gets electronic equipment back into service just as quickly as warm tubes reheat to safe operating temperatures. Starts operation *minutes sooner* when tubes have not completely cooled from a previous operation. It's safe. Cuts lost operating time. Standard 28V D. C. Other D. C. ranges on request. Units may be operated from 115V A. C. rectified source. Free bulletin.

------MAIL COUPON TODAY------

Eagle Signal Corporation, Dept. IA-157
Industrial Timers Division
Moline, Illinois
Please send Bulletin 820 with operation data and specifications on the new HYS series time delay relay.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

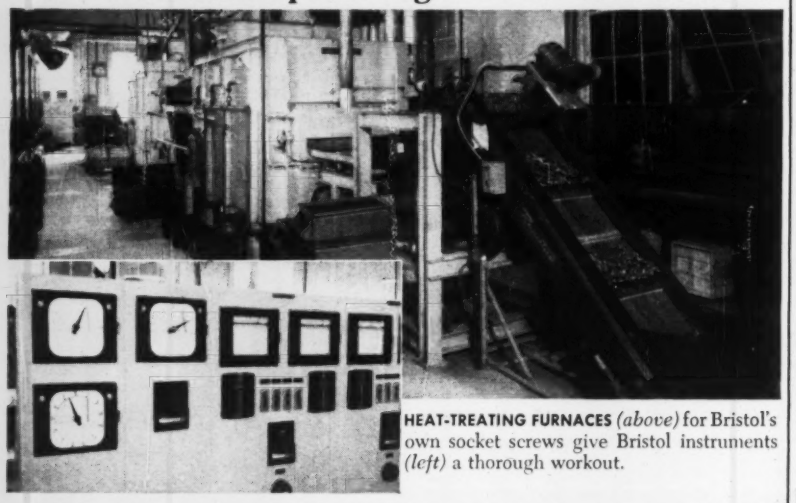
For more information circle **18** on inquiry card.

BRISTOL'S

Instrumentation News

• News of instrumentation and automatic control in industrial heating and metallurgy •

New instruments pass tough "field" tests at home



HEAT-TREATING FURNACES *(above)* for Bristol's own socket screws give Bristol instruments *(left)* a thorough workout.

New Bristol instruments for metal-treating operations have a ready-made proving ground in Bristol's own socket screw manufacturing division.

Bristol instruments monitor and automatically control every phase of the Socket Screw Division's metal treatment—including a variety of continuous and batch-type furnaces, salt-baths, and tinning and degreasing operations for specialty products.

Completely automatic control assures highest quality and uniformity for Bristol socket screw products. New instruments get grueling "field" tests before they're released for general distribution. And, last but not least, visitors to the Waterbury plant can see Bristol instruments under actual load conditions.

Drop in, when you're in the New England area, and watch these precision instruments at work!

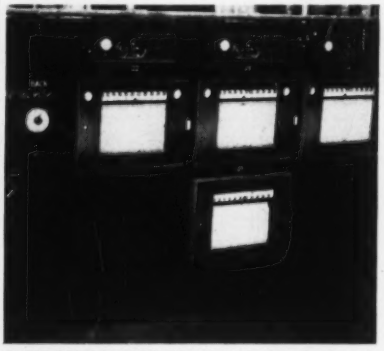
New control techniques cut fuel bills for metals

In 20 years, fuel required for ingot heating has dropped 50 to 60%.

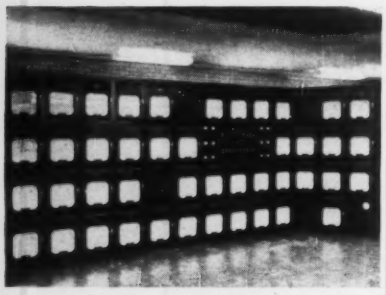
A big share of the credit for this fuel economy goes to automatic control and instrumentation techniques developed recently. These new techniques, with better, faster, more accurate sensing and response, have chalked up significant savings, not only in fuel, but also in fixed charges, rolling time, and maintenance costs.

Probably most important for big savings is control of furnace temperature and atmosphere. Furnace pressure may be regulated by positioning the stack damper. Fuel-air ratio can be controlled by a valve in the air line. Air requirements for combined fuels may be totalized for better distribution of fuel throughout the plant.

Proper temperature-time sequences or "time cycles" also rack up big savings. Step heating sequences, differing for various metal ingots, no longer need be programmed by rule of thumb. Instead, any predetermined sequence of temperatures can be maintained automatically and easily changed to suit particular batches.



THESE BRISTOL ELECTRONIC AND AIR-OPERATED pyrometers automatically control regenerative soaking pits. Platinum, platinum-rhodium thermocouples at pit covers are sensing elements.



Telemetering helps control steel plant fuel

This Bristol telemetering installation helps U. S. Steel, Gary, Indiana, get the highest steel production with the lowest possible fuel cost.

The panel shows the amount of coke-oven and blast-furnace gas used throughout the plant as well as gas pressures at critical locations. With this complete supply and demand information at their fingertips, fuel dispatchers can control distribution for maximum efficiency and economy.

Precision rolling mill produces steel tapes 0.000125" thick

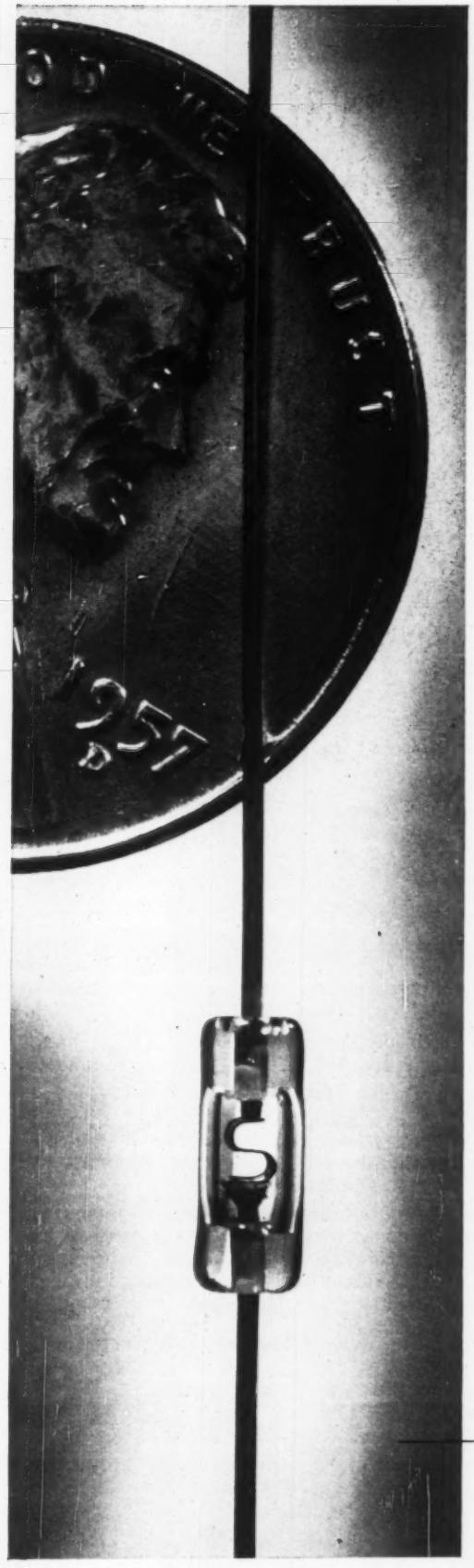
This precision cold-strip mill at The Arnold Engineering Company, Marengo, Illinois, rolls ultra-thin high-permeability strips for magnetic cores. The core strips may be as thin as 0.000125" and must be held to extremely close tolerances. To achieve the necessary precision, AccuRay gauges—employing Bristol Dynamaster recorders—measure thickness of material on both sides of the rolling mill. The AccuRay equipment is built by Industrial Nucleonics, Columbus, Ohio.

For more information circle **19** on inquiry card.

Want to apply these up-to-date control and instrumentation techniques to your industrial heating problem? Bristol engineers will be glad to talk over specific processes, problems, facts and figures with you. Write today to The Bristol Company, 113 Bristol Road, Waterbury, Conn.

BRISTOL *POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Hughes Quality | *means Highest Quality in*

HIGH-CONDUCTANCE SILICON DIODES

Hughes, long the leader for quality and reliability, has added another new series of Silicon Junction Diodes to the expanding line of Hughes Semiconductors.

Available now: HIGH-CONDUCTANCE SILICON JUNCTION DIODE TYPES HD6571, HD6572, HD6573, HD6574, HD6575 . . . HIGHER VOLTAGES . . . HIGHER CURRENTS . . . EXTREMELY HIGH BACK RESISTANCE . . . BREAKDOWN VOLTAGES TO 400V . . . HIGH FORWARD CURRENT . . . HIGH-TEMPERATURE OPERATION.

The first five types in this new series have been especially established to fill specific appplications requiring relatively moderate speed, with high voltage and high current. Examples: high-current clamping; magnetic amplifiers.

The entire series is packaged in the world-famous Hughes subminiature glass envelope, impervious to moisture and to other external contaminants.

ACTUAL SIZE. Diode Glass Body: Length: 0.265-inch, max. Diameter: 0.105-inch, max. Color: Opaque black enamel.

OPERATING TEMPERATURE RANGE: From −75°C to +150°C.

Our field sales engineers near you are ready to assist you in selecting the one Hughes germanium or silicon diode type best suited to your specific application. For further information, or for specifications covering the new Hughes High-Conductance Silicon Junction Diodes, please write:

SEMICONDUCTOR DIVISION
HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

HUGHES
SEMICONDUCTORS

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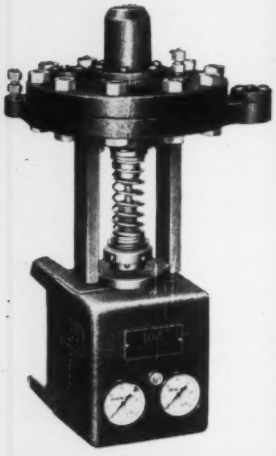
For more information circle **20** on inquiry card.

Here's the *pilot* with the *sense* to save *dollars*

Close Control



Leslie Type LA-2
Level Control Pilot

LESLIE FLOATLESS LEVEL CONTROL Pilots sense changes in liquid level that will help you maintain peak output. You save maintenance dollars, too — forget troublesome floats and cages (there aren't any).

With low resolution sensitivity (.1 of an inch change in level creates response), you are assured of smooth, throttling action and a closely held level.

You'll find Leslie Floatless Level Control Pilots in storage tank, boiler level and process vessel service — in fact, in any liquid level service where accuracy and dependability are important.

There are Leslie Pressure Control and Temperature Pilots with the sense to save dollars in pressure and temperature control stations, too. Your Leslie Engineer, listed under "Valves or Regulators" in your classified directory, will be glad to help you.

Send for Bulletin 5303 on Leslie Control Pilots

TRADE LESLIE MARK

REGULATORS AND CONTROLLERS

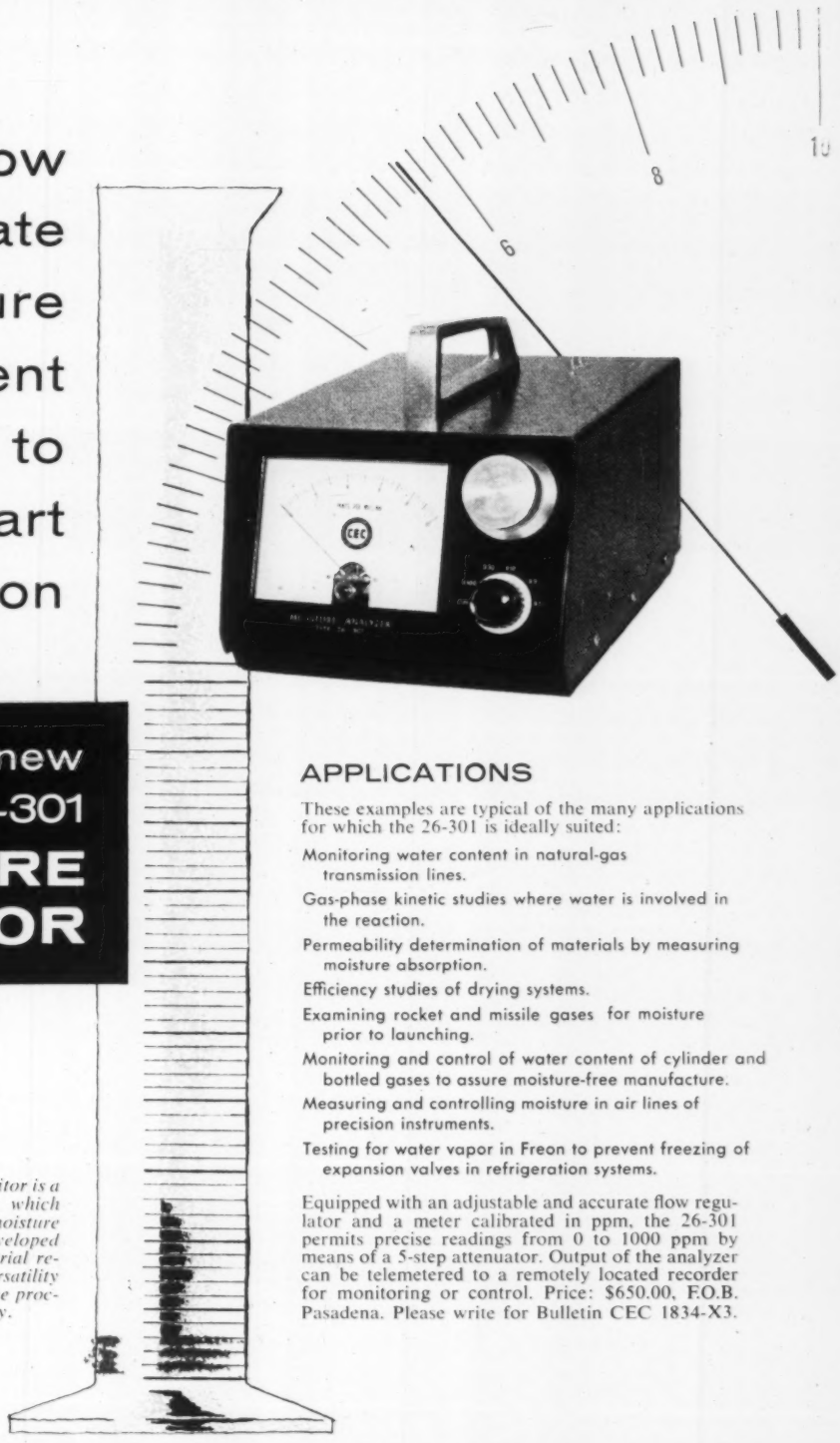
LESLIE CO., 299 GRANT AVENUE, LYNDHURST, NEW JERSEY

3573

CONTROLLED QUALITY MEANS QUALITY CONTROLS

For more information circle **21** on inquiry card.

Now get accurate moisture measurement . . . down to one part per million



CEC's new Type 26-301 MOISTURE MONITOR

The Type 26-301 Moisture Monitor is a portable, low-cost instrument which measures minute quantities of moisture present in gaseous mixtures. Developed to meet a wide range of industrial requirements, the instrument's versatility makes it equally adaptable to the process plant or analytical laboratory.

APPLICATIONS

These examples are typical of the many applications for which the 26-301 is ideally suited:

- Monitoring water content in natural-gas transmission lines.
- Gas-phase kinetic studies where water is involved in the reaction.
- Permeability determination of materials by measuring moisture absorption.
- Efficiency studies of drying systems.
- Examining rocket and missile gases for moisture prior to launching.
- Monitoring and control of water content of cylinder and bottled gases to assure moisture-free manufacture.
- Measuring and controlling moisture in air lines of precision instruments.
- Testing for water vapor in Freon to prevent freezing of expansion valves in refrigeration systems.

Equipped with an adjustable and accurate flow regulator and a meter calibrated in ppm, the 26-301 permits precise readings from 0 to 1000 ppm by means of a 5-step attenuator. Output of the analyzer can be telemetered to a remotely located recorder for monitoring or control. Price: $650.00, F.O.B. Pasadena. Please write for Bulletin CEC 1834-X3.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

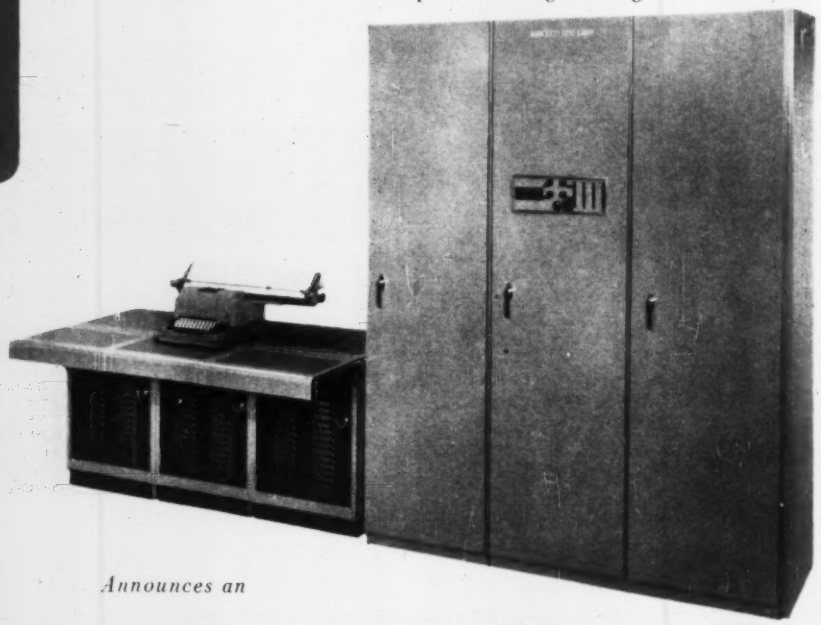
NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICE

For more information circle **22** on inquiry card.

KYBERNETES

THE KYBERNETES CORPORATION

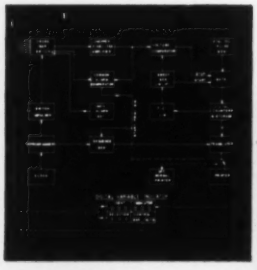
Division of Self Winding Clock Company, Inc.
for 70 years leader in time standards
and precision engineering

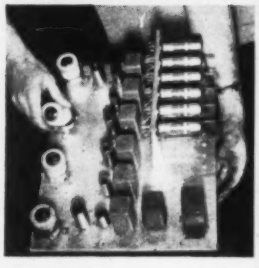


Announces an

ALL ELECTRONIC LINE OF AUTOMATIC DATA PROCESS LOGGERS

A revolutionary engineering concept, the
Kybernetes Electronic Data Logger
puts to use designs largely predicated
upon advanced techniques
developed by the computer industries,
featuring reliability and accuracy.





KYBERNETES

Write for Bulletin '108'

THE KYBERNETES CORPORATION

Executive Offices:
9 East 40th Street
New York 16, N. Y.
MUrray Hill 3-6030

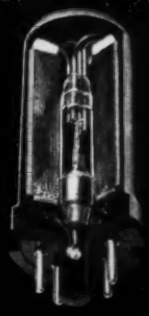
For more information circle **23** on inquiry card.

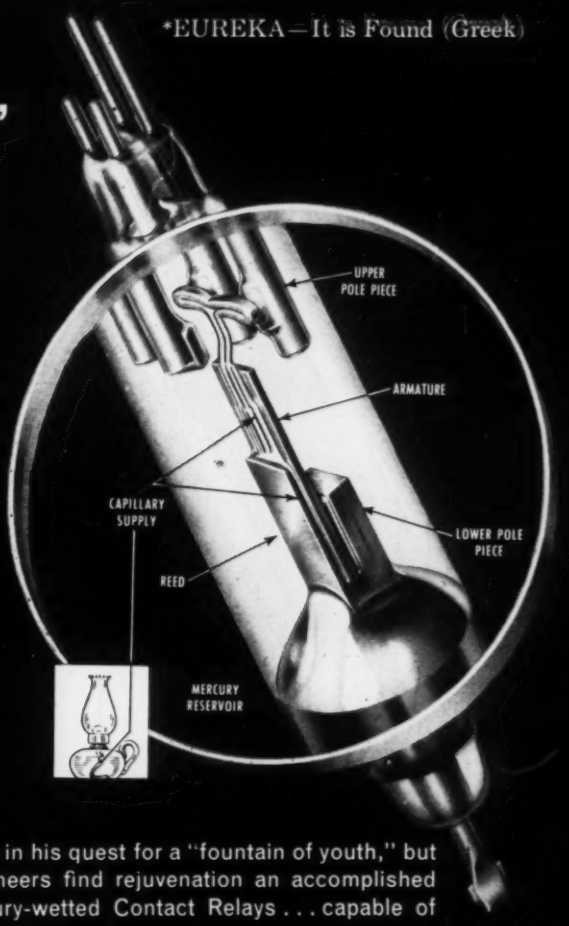
Circle **11** on inquiry card. ⟶

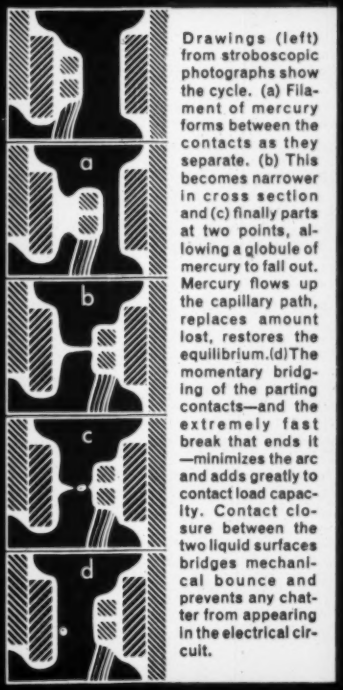
ΕΥΡΗΚΑ*

*EUREKA—It is Found (Greek)

INDUSTRY FINDS A "FOUNTAIN OF YOUTH" IN THIS SELF-REJUVENATING CLARE RELAY







Drawings (left) from stroboscopic photographs show the cycle. (a) Filament of mercury forms between the contacts as they separate. (b) This becomes narrower in cross section and (c) finally parts at two points, allowing a globule of mercury to fall out. Mercury flows up the capillary path, replaces amount lost, restores the equilibrium. (d) The momentary bridging of the parting contacts—and the extremely fast break that ends it—minimizes the arc and adds greatly to contact load capacity. Contact closure between the two liquid surfaces bridges mechanical bounce and prevents any chatter from appearing in the electrical circuit.

Ponce de Leon failed in his quest for a "fountain of youth," but modern design engineers find rejuvenation an accomplished fact in CLARE Mercury-wetted Contact Relays . . . capable of billions of operations.

Contacts of these relays are constantly renewed: By capillary action, like that of a lamp wick, a new film of mercury coats the contacts with every make and break.

The magnetic switch is sealed in a high-pressure hydrogen atmosphere in a glass capsule. Surrounded by the operating coil, the capsule is enclosed in a vacuum-tube-type steel envelope.

Unlike ordinary relay contacts, these contacts never wear out; never get dirty; never lock or weld; never get out of adjustment; never bounce.

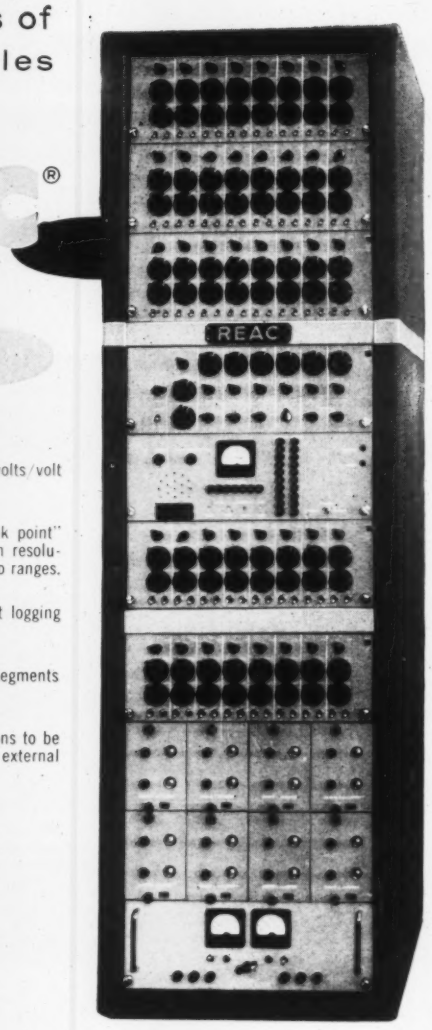
Send for CLARE Engineering Bulletins No. 120 and 122. Address C.P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare & Co., 659 Bayview Avenue, Toronto 17. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

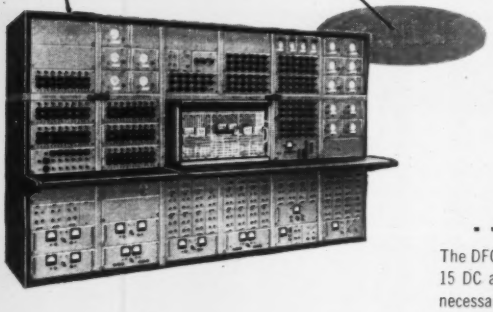
Generation of Functions of *Two or More* Variables

with the 400 series REAC®



DIODE FUNCTION GENERATOR

- Allows direct generation of slopes up to 12 volts/volt without paralleling diode segments.
- 10-turn potentiometers for both "slope" and "break point" give excellent resolution. Still further improvement in resolution is obtained by splitting slope adjustment into two ranges.
- 1000-division direct read-out 10-turn dials permit logging of function for fast reproduction later.
- Flexible switching system allows number of segments per channel to be varied from 2 to 30.
- Built-in calibration circuit permits functions to be set up quickly and easily without use of external plotting board.



. . . a complete self-contained unit

The DFG-401 is a completely self-contained unit consisting of 5 channels of function generation, 15 DC amplifiers (with VTVM and all control circuits for monitoring and balancing), and all necessary power supplies (except relay and reference voltages). In the event that any amplifiers supplied are not needed in the problem, they can be made available in groups at the patchbay as inverters with one gain of one.

This unit is ideal for the addition of up-to-date diode function generation equipment to an existing analog computer installation.

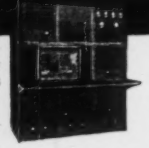
Electronic generation of functions of two or more variables is another outstanding Reeves contribution to the flexibility and efficiency of the electronic analog computer. Before installing new equipment, it will pay you to consult us. A comprehensive new REAC "400" series computer technical brochure will be sent upon request.

2RV57

Reeves INSTRUMENT CORPORATION

REEVES INSTRUMENT CORPORATION

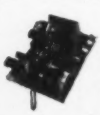
A Subsidiary of Dynamics Corp. of America, 225 East 91st St., New York 28, New York



REAC Analog Computers

Precision Floated Gyros

Precision Resolvers and Phase Shifters



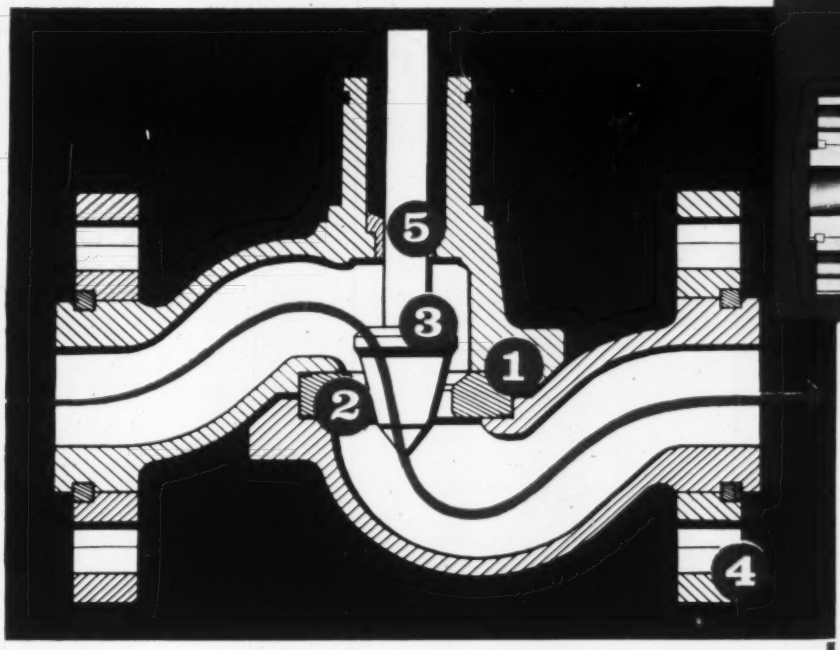
Servo Mechanical Parts

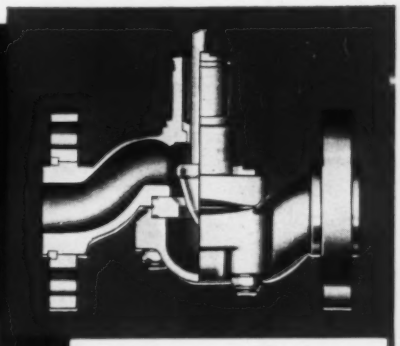
For more information circle **24** on inquiry card.

ANNIN BODY DESIGN

...THE SOUNDEST APPROACH TO TROUBLE-FREE FLUID CONTROL

Reduces body turbulence and erosion • Longer seat ring life—retains tight closure • High lift in all sizes for better control—greater rangeability • Fewer parts—simplified and much lower maintenance.

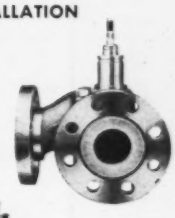


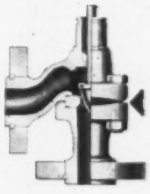


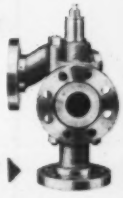
GLOBE BODY ▲

The basic form of all Annin Valves. Reduces number of parts 50 to 75%, lowers initial costs, saves on parts inventory and maintenance.

OTHER BODY DESIGNS PROVIDE FLEXIBILITY IN INSTALLATION







Annin Valves are the answer to the complex fluid control problems common in the process industries—Chemical, Petroleum, Paper, Steam, Power Plants, and many others. Today, Annin Valves are recognized by control engineers and valve designers as the outstanding valve development of the past twenty-five years for the control of hot, cold, erosive, or viscous liquids.

• • •

1 BODY. Single seat split body construction eliminates pockets and shoulders... reduces erosion.

2 SEAT RING. The body flanges retain seat in perfect alignment with valve plug.

3 VALVE PLUG AND STEM. Valve plugs are contoured to provide either linear, percentage, or semi-throttle characteristics... reduce turbulence, wire drawing, plug vibration and noise.

4 SEPARABLE FLANGES. Can be interchanged at will. Carbon steel flanges can be mounted on alloy bodies for economy.

5 PLUG GUIDE. Hard metal guides of close tolerances can be inserted through stuffing box without resorting to threads, welding, pressing or staking.

ANNIN THE ANNIN COMPANY
6570 EAST TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA
Control VALVES

For more information circle **25** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

1956 Year-End Review by Sinclair Weeks, SecCom:
Gross National Product–$412 billion (5% above 1955)–but half of this was due to price rise.
Personal income–$325 billion (6% above 1955).
Total employment–65 million (3% above 1955)–but manufacturing employment was steady.
Disposable personal income taxes–up 6% in dollars (4% in real purchasing power).
Exports of goods and services–$24 billion (up 14%).
Imports of goods and services–$20 billion (up 5%).
Consumer price index–up 2½%.
Comment–Bear in mind 3% US annual population increase.

During 1956, 134 industrial firms started using radioactive isotopes for the first time. Of these, 46 applied them to gaging and 28 for radiographic inspection. Total now using isotopes is 1121 firms. More than 20 firms have built or plan to build major radiation research centers.

1956 Year-End Review by Atomic Industrial Forum:
U. S. Atomic industry (not including the AEC Laboratories) in 1956 received contracts or began construction of 59 new nuclear reactors, including 30 research types (14 for export, 9 for government, and 7 for private buyers) and 29 power types (14 for propulsion of naval vessels, 6 for land-based power demonstration, 4 prototypes for AEC, 4 for export, and 1 for merchant-vessel propulsion). In addition to these 59, work was carried forward on 17 reactor contracts awarded previously, including the 65,000-kw Shippingport reactor. Prior to 1956, the atomic industry (not including the AEC Laboratories) had completed 28 reactors, including the Nautilus and Seawolf prototypes.

Uranium ore production in 1956 in U. S. totaled 3 million tons (6000 tons of U_3O_8 uranium concentrate). Present rate of 8000 tons per year is double the 1955 rate.

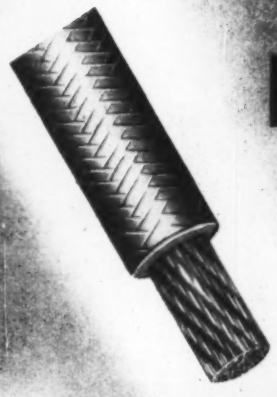
1956 Year-End Review of CAA:
Number of U. S. active civil aircraft–65,250 (up 8%).
Number of scheduled air carrier aircraft–1690 (up 13%).
Number of U. S. civil and military airports–6900 (up 1%).
Landings and takeoffs, CAA towers–21.7 million (up 12%).
En route position reports posted–25.3 million (up 23%).
Domestic revenue passenger miles–22 billion (up 13%).
International revenue pass.-miles–5 billion (up 15%).
Scheduled airline passengers–45.8 million (up 11%).
Passenger fatalities–143 in 4 accidents (down 10%).
Fatalities per 100 million miles–0.50 (down 15%).
Applications for approval of jet engines moved ahead of piston engine projects, 21 to 18.

HIGH TEMPERATURE MOISTURE and FIRE RESISTANT ELECTRICAL CABLE *for AIRCRAFT*

LEWIS

to MIL-C-25038

FOR SUPERIOR WET DIELECTRIC STRENGTH, ABRASION RESISTANCE, HIGH TEMPERATURE AND FIRE RESISTANCE, AS WELL AS RESISTANCE TO OIL, FUEL, HYDRAULIC FLUID AND SALT WATER —



USE *LEWIS* HT CABLE FOR CRITICAL CIRCUITS

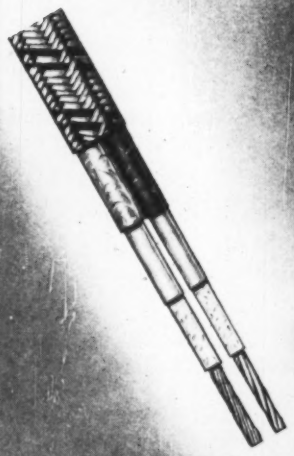
AVAILABLE IN AWG SIZES FROM #20 TO #4/0

AWG	AWG	AWG
20	10	1
18	8	0
16	6	00
14	4	000
12	2	0000

WE MAKE CABLE TO DO SPECIFIC JOBS. TELL US ABOUT YOUR PROBLEM.

SPECIFY *LEWIS* MIL THERMOCOUPLE WIRE
FOR PERMANENT AIRCRAFT INSTALLATIONS

CORRECTLY CALIBRATED TO INSURE AIRCRAFT ACCURACY AND WITH LEWIS LAMINATED INSULATION TO MAINTAIN CIRCUIT INTEGRITY



MIL-W-5908A

COPPER-CONSTANTAN
THERMOCOUPLE WIRE AND LEAD WIRE
TYPE I CLASS A, B, C, D, E, F AND G
TYPE II CLASS A AND B
TYPE III CLASS A AND B
TYPE IV CLASS A AND B
TYPE V CLASS A AND B

MIL-W-5846A

CHROMEL-ALUMEL
THERMOCOUPLE WIRE AND LEAD WIRE
TYPE I CLASS A, B, C, D AND E
TYPE II CLASS A
TYPE III CLASS A
TYPE IV CLASS A

MIL-W-5845A

IRON-CONSTANTAN
THERMOCOUPLE WIRE AND LEAD WIRE
TYPE I CLASS A, B, C, D, E, F, G, H, I AND J
TYPE II CLASS A, B AND C
TYPE III CLASS A, B AND C

PRODUCED IN OUR OWN WIRE MILL, LEWIS THERMOCOUPLE WIRE AND LEWIS HIGH TEMPERATURE ELECTRICAL CABLE ARE BUILT TO MEET AND IN MANY CASES EXCEED, THE RIGID SPECIFICATION REQUIREMENTS.
Write for Wire Products Catalog No. 953

THE LEWIS ENGINEERING CO.
NAUGATUCK, CONNECTICUT

For more information circle **26** on inquiry card.

INSTRUMENTS and AUTOMATION News

Principles & Applications .....34 to 42
Stock Report 42
New Plants & Mergers 49
People in the News 53

Revolutionary New Magnet

WEST LYNN, MASS.—General Electric's West Lynn Measurements Laboratory has announced a revolutionary and potentially super-strong magnet material. Made from iron dust particles smaller than the wavelength of light and visible only under an electron microscope, it is rated ten times the strength of Alnico, hitherto the most important and strongest magnet material available. It contains no cobalt or nickel—metals of high strategic value—and opens vistas for use in nuclear reactors, where use was prohibitive to this time due to the cobalt's potential radioactivity.

Dr. T. O. Paine collects submicroscopic particles of magnetic material from a pool of liquid metal with a magnet.

Credited with the development of this wonder magnet is Dr. Thomas O. Paine, who as manager of the laboratory, led the team of 20 scientists to success.

Examining a drilled and tapped sample of the new magnetic material.

A billion billion of these elongated sub-microscopic particles are required to form a mass weighing only one pound. The material can be embedded in plastics, metals, rubber, or glass. It can be drilled, tapped, and molded into any desired shape, and constitutes a major breakthrough on the road to electric instruments that are smaller, lighter, more accurate, and more rugged.

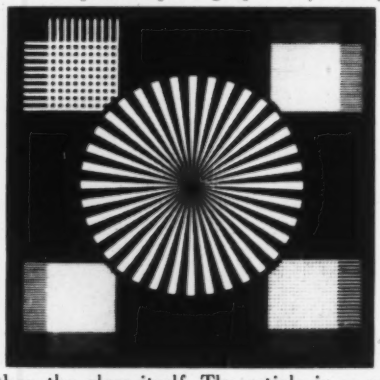
Richard Rimbach Session Chairman at IRE Conference

The Second IRE Instrumentation Conference, sponsored by the Atlanta Section of the IRE and the Professional Group on Instrumentation, held December 5-7, 1956, drew an attendance of 800, and included an exhibit of products from more than 100 manufacturers. Richard Rimbach, publisher of *Instruments & Automation* served as chairman of the Industrial Applications session.

Diadur, German Reticle Process

PASADENA, CALIF.—The famed German Heidenhain reticle process, Diadur, is now being offered in the U. S. for the first time.

The Diadur process reproduces a master line drawing onto glass as a precise photographic dye image, more durable than the glass itself. The reticle is so small that one of the four quadrants can be hidden under a halftone dot of the illustration shown. The finest cross-hatching in one of the quadrants is 5 microns square.



The Heidenhain Diadur reticles have found use as glass measuring scales (height gauges), electronic weighing scales, optical tooling, micrometers, binary coded discs, theodolites and photo theodolites, standardized test plates, fire control systems, range finders, and many other visual measuring instruments. Bushnell Optical Enterprises are the licensees.

Electronic Filing Unit

NEW YORK CITY.—An electronic filing device—using short lengths of magnetic tape to provide compact storage and rapid access to almost unlimited volumes

WHY SETTLE FOR LESS?

"The authority on controlled power for research and industry"

WHEN YOU SPECIFY POWER SUPPLIES

. . . you are entitled to all of the benefits of complete facilities, thoroughly experienced engineers, wide product range, prompt delivery and competitive prices.

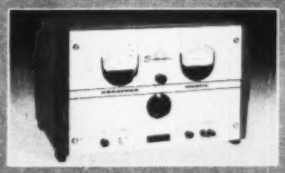
WHY SETTLE FOR LESS?

Take a standard DC requirement, anywhere between 6 and 1000 volts. You need a good, reliable standard DC source — you want to be able to install it and forget it. You want it promptly and, since it's a standard item, you want it for a reasonable price.

If you investigate Sorensen's "Nobatron"* group — more than 70 models available "off the shelf" — and look a bit deeper than the electrical and mechanical specs, here's what you'll find:

*Reg. U.S. Pat. Off. (NO BATTERIES — ELECTRONIC CONTROL)

THE OUTSIDE APPEARANCE—

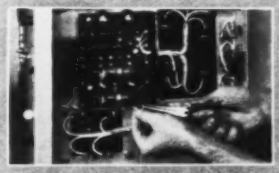


clean, functional, careful attention to small details. Not always vital, but indicators of quality design, workmanship, and materials.

INSIDE, TOP QUALITY COMPONENTS —

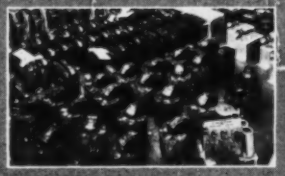
rugged construction — sound engineering proved by tens of thousands of successful units.

NEAT, UNCLUTTERED WIRING —



firm, long lasting connections — hallmarks of skilled people. You don't learn this workmanship overnight, but it's the key to a reputation for precision.

IF WE CAN MAKE A COMPONENT BETTER, WE DO.



If somebody else can do it better, more economically and faster — like we make power supplies — we buy it. Either way, it means better quality for you.

THE ACCUMULATED EXPERIENCE OF SORENSEN'S ENGINEERING STAFF —

specializing in power control — is more than 215 man-years. That means less "second guessing," less engineering time, faster delivery, lower cost. And better units.

OUR SALES ENGINEERING STAFF AND MANUFACTURERS REPRESENTATIVES

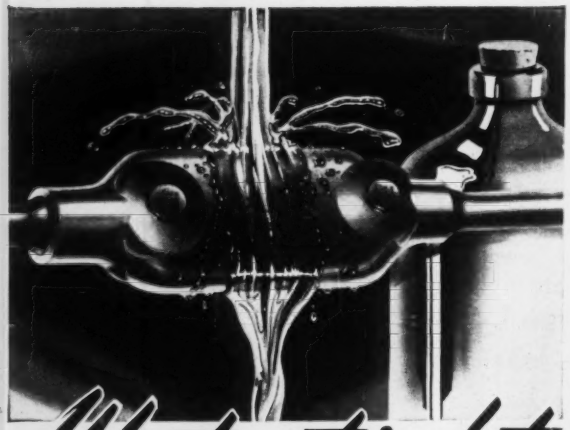
work together to put all of these facilities, all of this experience, at your immediate disposal. All it takes is a phone call.

In short, don't just buy "a power supply." Whether it's a precision regulated source for a special job, or a standard low cost unit, start with Sorensen . . .

SORENSEN & COMPANY, INC. 375 FAIRFIELD AVE. • STAMFORD, CONN.

In Europe, contact Sorensen-Ardag, Eichstrasse 29, Zurich, Switzerland, for all products including 50 cycle, 220 volt equipment.

For more information circle **27** on inquiry card.



Watertight

. . . as a CORKED BOTTLE

Moisture cannot penetrate the one-piece Neoprene body of a JOY electrical plug . . . when engaged, even its contacts are enclosed in a protective Neoprene housing through the *cork-like* action of JOY's famous water-seal. Permanently vulcanized to cable, it cannot crack . . . won't lose its shape . . . and requires no special considerations to insure a long life of useful service. A favorite since '26, JOY electrical connectors are now available in styles and sizes for nearly any portable electrical power transmission need. Why risk electrical misfits when the best actually costs less, in the long run?

A DESIGN FOR EVERY NEED

(1) PUSH-LOCK DESIGN
A twist of the wrist locks them together. No. X8164- , illustrated.

(2) PUSH-LATCH DESIGN
Best for small tools and lighting. No. X8142- , illustrated.

(3) ROUND DESIGNS
Excellent for many standard uses. No. X8108- , illustrated.

(4) OVAL DESIGNS
Lay flat. Offer less obstruction. Favorites. No. X8036- , illustrated.

(5) (S.P.B.) DESIGNS
For heavier currents. Have threaded couplings. No. X8223- , illustrated.

Write for complete information today!

Ask for your free copy of Bulletin B59a describing many of JOY'S outstanding Electrical Connectors in detail. It will be mailed promptly without obligation.

see our CATALOG in SWEET'S FILE

CD 354.2

More than 100 years of Engineering experience

JOY MANUFACTURING COMPANY

ELECTRICAL PRODUCTS DIV. • 1201 MACKLIND AVE. • ST. LOUIS 10, MO.

EXECUTIVE OFFICES, HENRY W. OLIVER BLDG., PITTSBURGH 22, PA.

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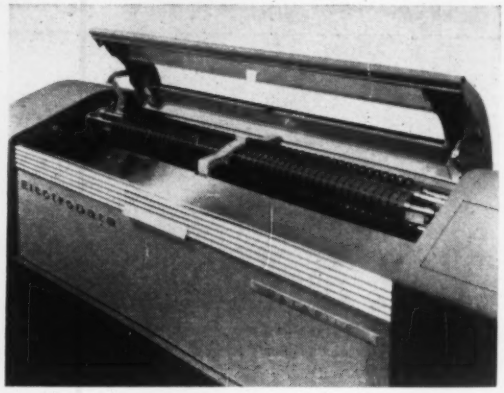
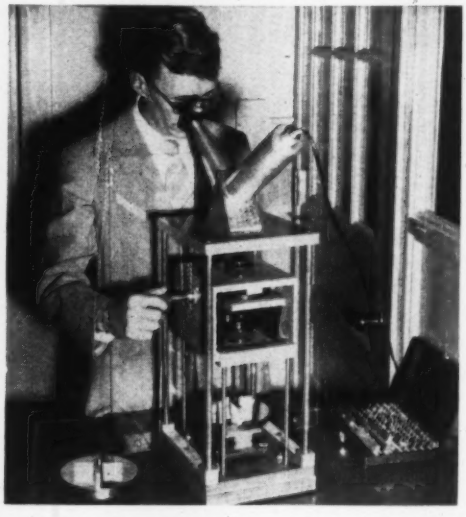


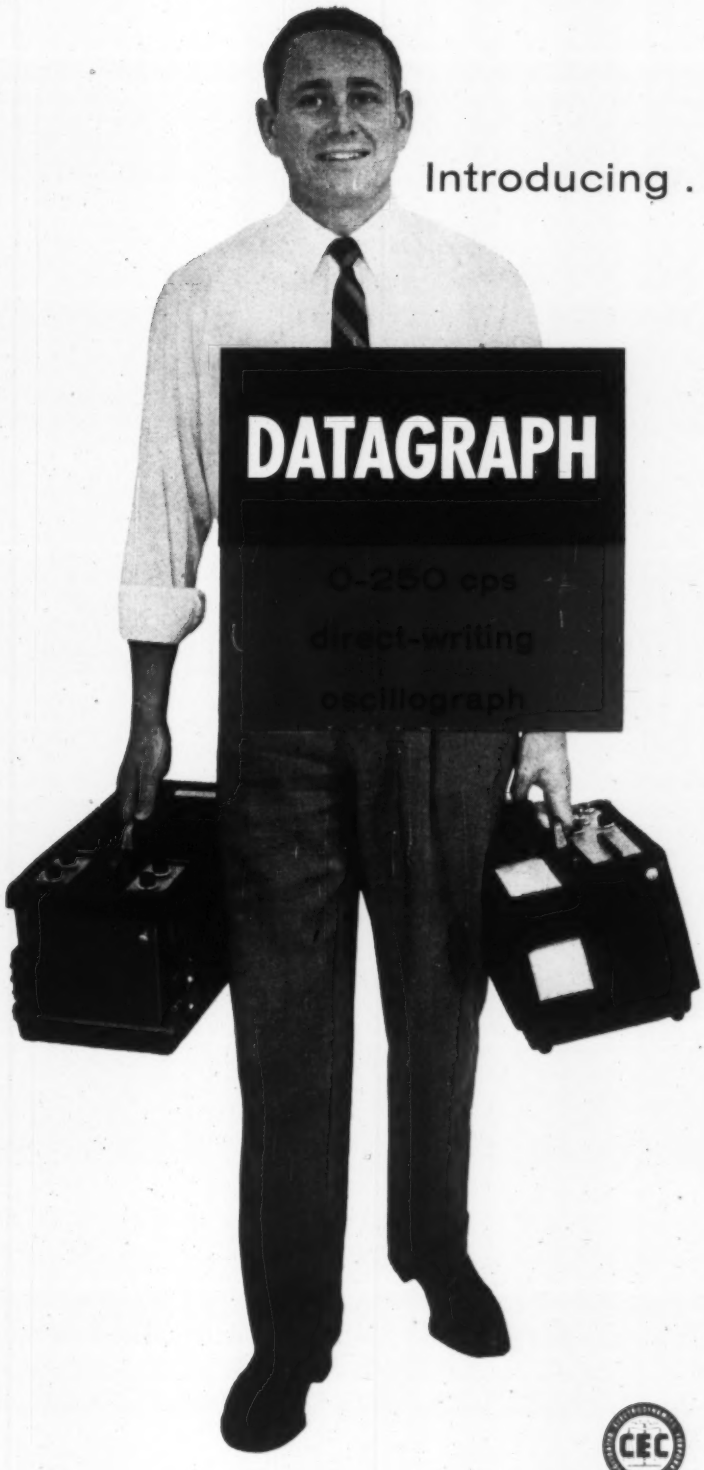
of business information—has been unveiled by Burrough's Electrodata Div. at the Eastern Computer Conference. Each "DATAFILE" stores 20-million characters in a single memory unit the size of an ordinary deep-freeze.

High-Precision Comparator

WASHINGTON, D. C.—National Bureau of Standards has developed an interfermometric comparator that compares length to the nearest ten-millionth of an inch. The



instrument will check lengths of industry's master gage blocks. Extremely small dimensional tolerances now required for parts used in guided-missile, jet-aircraft, machine-tool and other industries have caused manufacturers to request that the Bureau develop procedures for calibrating on a routine basis to *one part in ten million.* The interferometric comparator represents an important step toward the goal of this program. Major problem remaining is the development of means for absolute calibration, to the nearest ten-millionth of an inch, of the Bureau's primary standard gage blocks. Because of the extreme importance of this work, Congress has provided a substantial increase in the Bureau's appropriation, specifically requesting increased effort on the project. Major industrial firms have also provided a three-year grant to assist in the necessary research.



Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

WHAT IS IT? A completely new, direct-writing oscillograph/amplifier system for providing an immediate, permanent record of rapidly varying voltages. Its frequency response, portability, flexibility are beyond those of any similar equipment on the market today.

WHAT ARE ITS FEATURES? Excellent square-wave and transient response, and frequency response to 250 cycles. It will record at *1" double amplitude throughout the frequency range of 0 to 250 cycles!* The recording system uses no ink . . . traces are clean and easily interpreted. Push-button speed selector provides instantaneous change of the record's time base.

WHERE CAN YOU USE IT? Datagraph can be used to record voltages from many sources . . . e.g., magnetic-tape playback units, carrier amplifiers, audio amplifiers, d-c amplifiers, telemetering discriminators, etc. Its high input impedance adapts it to a myriad of input devices.

WHAT ARE THE SYSTEM SPECIFICATIONS?

FREQUENCY RESPONSE....flat ±5% from 0 to 250 cps.

RECORD SPEEDS.....0.05, 0.2, 1, 5, 10 and 20"/sec.

NUMBER OF CHANNELS....2

RECORD SIZE.....70 mm x 500 ft.

AMPLIFIER INPUT IMPEDANCE .....100,000 ohms

SENSITIVITY .....1 inch per volt; 1 inch maximum peak-to-peak amplitude

DIMENSIONS AND WEIGHT:

Oscillograph .....9" x 10½" x 17¼", 60 lbs.

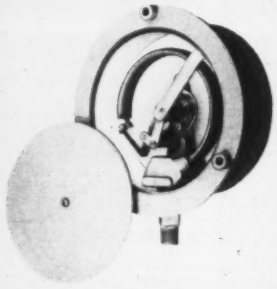
Amplifier .....9" x 10½" x 17¼", 50 lbs.

WHERE'S THE COMPLETE STORY OF DATAGRAPH?

In a new CEC bulletin, just released. Send for your copy of Bulletin CEC 1569-X5.

For more information circle **29** on inquiry card.

HOW TO ORDER *Safety*

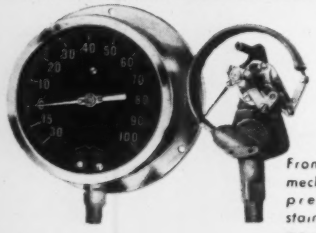


Rear view of Safety Gauge showing safety plate and metal wall separating bourdon from scale

All Weksler pressure gauges can now be furnished with the SG SAFETY GAUGE feature. In the event of bourdon tube rupture due to excessive pressure, corrosion or other weakening factor, this mechanism allows the back plate to lift, releasing the pressure force without becoming detached from the instrument. This ingenious device thus affords safety both in front and back of gauge.

AND MORE *Safety*

For extra safety in the presence of corrosive acids or fumes Weksler now makes available a complete line of STAINLESS STEEL Gauges in four standard sizes — Type 916 RR with stainless steel bourdon and alloy steel socket, or Type 917 RR with all stainless steel bourdon and socket.



Front view and internal mechanism of Type 917 RR pressure gauge with stainless steel bourdon, movement and socket

For further information about these and other DIAL INDICATING AND RECORDING PRESSURE AND VACUUM GAUGES send for our completely revised Catalogue No. 525A.

YOUR GUARANTEE WEKSLER INSTRUMENTS OF SATISFACTION

WEKSLER THERMOMETER CORP.

195 E. MERRICK ROAD, FREEPORT, L. I., N. Y.

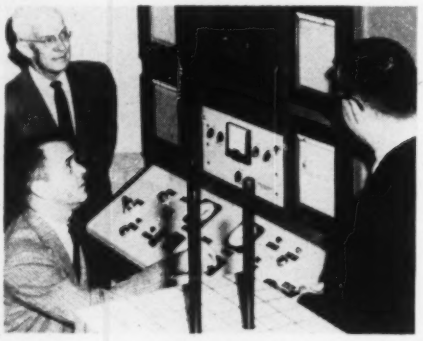
For more information circle **30** on inquiry card.

Education News of the Month

Among the proposed remedies to alleviate the serious shortage of scientists and engineers, the idea of *teaching the teacher* has brought repercussions in several instances:

♦ The National Science Foundation has taken the lead with a grant of $303,000 to MIT to support a two-year study of physical-science teaching in secondary schools. A committee under the direction of Jerrold R. Zacharias, Professor of Physics at MIT, which includes some of the foremost physical scientists in the U. S., will make an effort to improve presentation of high-school subject matter and provide teachers with better textbooks, better materials, and better instruction techniques.

♦ The nuclear reactor simulator has reached the Nation's schools. *Leeds & Northrup's* model which was first shown at the "Atoms for Peace" Conference at Geneva, Switzerland, has been improved by addition of a natural uranium exponential reactor, and the new version of the simulator has been installed at the atomic energy lab of Virginia Polytechnic Institute. V. I. P. will use it to train graduate engineers in nuclear theory and operation.



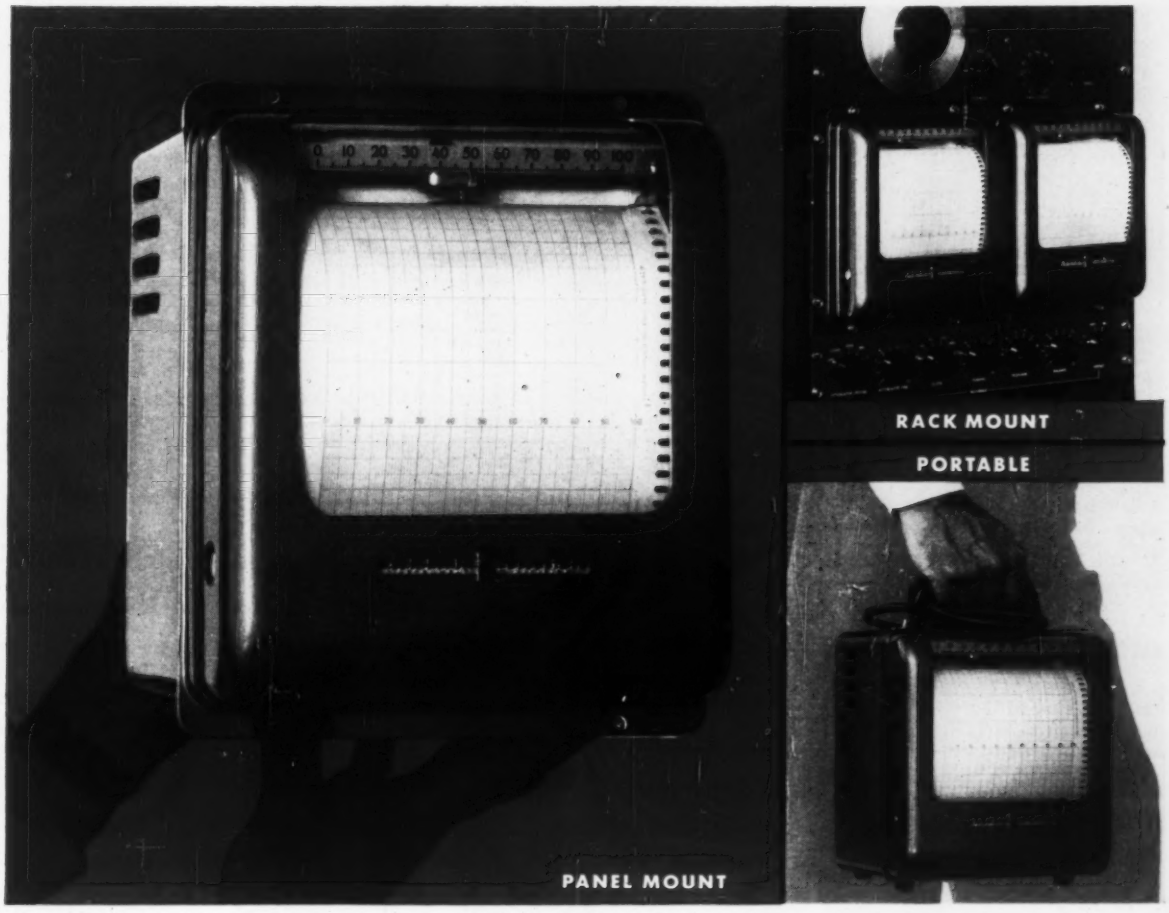
Reactor simulator for nuclear training.

♦ Television Shares Management Corp. announced the establishment of three fellowships of $2000 each at three major universities "to aid graduate students . . . to further their teaching careers" in electronics. Encouragement and support of teachers to train the engineers was recognized as the prime consideration in attacking the problem of the increasing shortage in technical brainpower.

♦ Another approach to the problem was offered by RADM. H. G. Rickover, of "Nautilus" fame, at a recent luncheon sponsored by the Thomas Alva Edison Foundation, Inc.: Give the talented pupil extra consideration in model academic secondary schools. Entrance exams would be required which only the mental elite would pass; teachers' salaries would be comparable to positions in industry. One teacher for 20 pupils would be provided. The course would start with the fifth grade and pupils would be ready for college at age 16. Extending our regular school year of 180 days to 210 days was also proposed. Said Adm. Rickover: "There is no other country of comparable civilization where children go to school for only 180 days as they do here . . . Our high schools may excel in turning out pleasant and attractive youngsters, but their heterogenous character makes them poor institutions for training the talented." In defending this seemingly "undemocratic" separation, Adm. Rickover used the term "our presently most neglected national resource—the talented child."

NEW STRIP CHART POTENTIOMETER RECORDER $395

THE G-11 . . . VARIAN'S NEWEST ACHIEVEMENT



This new, low-cost recorder with **unitized measuring circuit** makes field adjustment to your requirements as simple as changing a tube. Quantity production from precision tooling assures uniformly high quality and fast delivery.

- 9 mv to 100 mv span, continuously adjustable
- 1 sec. balancing time — 1% limit of error
- High permissible source resistance — in excess of 50 K ohms
- Weighs less than 15 pounds
- Compact: only 8⅝" x 10⅜" x 7¾" (5¼" behind panel)

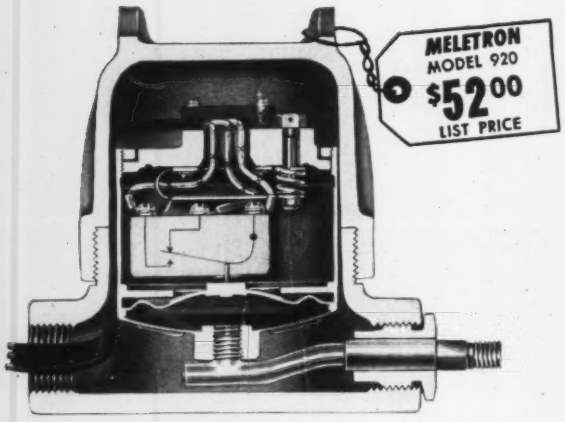
WRITE TODAY FOR COMPLETE SPECIFICATIONS
on the new **G-11** Recorder and its unique companion, the G-10 Graphic Recorder.

Microwave Tubes . Instruments

VARIAN associates
INSTRUMENT DIVISION

Representatives in all principal cities

PALO ALTO 27, CALIFORNIA
For more information circle **31** on inquiry card.



Here's the Simplest Diaphragm Pressure Switch for Explosive Atmospheres

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	**LINKAGES & BEARINGS** which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements.	**LIQUID SWITCHING ELEMENTS** which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	**ACCORDION DIAPHRAGMS** which make the pressure switch sensitive to vibration.

To get complete specifications and operating data ask for bulletins 920-925.

BARKSDALE VALVES

PRESSURE SWITCH DIVISION

5125 Alcoa Avenue, Los Angeles 58, California

For more information circle **32** on inquiry card.

News Bits

FISCHER & PORTER CO. has been awarded a contract by Pratt & Whitney Div., United Aircraft Corp. for an automatic data reduction system for use in engine test cells.

TELEVISION-ELECTRONICS FUND, INC. reports total assets at the end of fiscal year on Oct. 31 were $132,618,446, an increase of 25.3 per cent over last year.

Giant telescopic tracker capable of tracing a missile 300 miles away has been developed at the Army Signal Corps Engineering Laboratories at Fort Monmouth, N. J. The new one-and-a-half ton optical collossus has a 400-pound lens systems developed by **FAIRCHILD CAMERA AND INSTRUMENT CORP.** which clearly shows fast moving aerial objects in natural color on the instrument's scope or takes black and white photographs of rockets, jets and other flying objects automatically.

RAYTHEON MANUFACTURING CO. has received the biggest single order for electronic equipment ever placed by the Civil Aeronautics Administration. The order, amounting to approximately $9 million, is for 23 long-range radars.

STROMBERG TIME CORP., a subsidiary of General Time Corp. has begun manufacture of "Transacter" electronic business data processing system.

LEEDS & NORTHRUP CO. has developed a measuring system for fast checking temperatures of molten metals and alloys—both ferrous and non-ferrous—at temperatures to 3200F. The system employs a lightweight immersion thermocouple used in combination with a portable electronic indicator or permanently mounted recorder.

←L & N measuring system

Regent graphic panel

REGENT CONTROLS, INC., has been commissioned to build a graphic instrument control panel to be installed in Dorr-Oliver designed phosphoric acid plant now under construction for a Norwegian fertilizer manufacturer.

GENERAL ELECTRIC CO. has developed a remote-controlled microscope at the Hanford plutonium plant to study changes that occur in microstructure of metals exposed to chain-reaction bombardment.

BERKELEY DIV., BECKMAN INSTRUMENTS, INC. has developed a digital-readout flow indicator and control system comprising a Waugh flowmeter, a Model 5692 digital flow indicator, and a Model 1452 digital printer. System can control programs and processes on a time vs flow basis.

TEXAS INSTRUMENTS INC. has completed installation of an IBM 650 Magnetic Drum Data Processing

HUGHES PRODUCTS

presents 3 unusual new

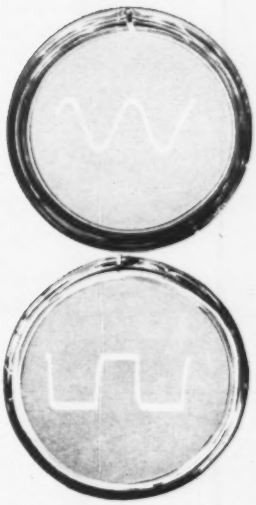
STORAGE TUBES

MEMOTRON

The MEMOTRON, a direct-display cathode ray storage tube, retains traces and transients until intentionally erased. Analysis and comparison are possible without photography because MEMOTRON visually displays successive transient writings. All displays occur at uniform brightness, regardless of writing speeds, so are easily photographed for file records. Applications: viewing transients in shock testing, read-out of solutions from analog computers, curve plotting at high and low speeds, electrocardiography, vectorcardiography and heart sounds.

General Specifications:

RESOLUTION...50 to 60 written lines per inch.
WRITING SPEED...0 to at least 100,000 inches/second.
BRIGHTNESS...50 foot-lamberts.
USABLE SCREEN DIAMETER...4 inches.
DIMENSIONS...
Over-all length: 18 1/2 inches ± 1/2 inch.
Bulb diameter: 5 5/8 inches maximum.
Neck diameter: 2 1/4 inches ± 3/32 inch.



Photos show single transient pulses, 20 microseconds wide with a one microsecond rise time, showing writing capabilities of one million inches per second. These photos were taken in full daylight without a hood.

TONOTRON

The TONOTRON, another exclusive Hughes direct-display cathode ray storage tube with a 5-inch screen, presents a complete spectrum of grey shades. The high light output makes a hood unnecessary, even when viewing in full daylight. TONOTRON's length of persistence and rate of decay are controllable. Superior presentation of the grey scale assures "high fidelity" picture reproduction. Applications: radar, Narrow Band Television, instrumentation, etc.

Photos: Left, weather radar with brilliant halftone picture on TONOTRON. Right, TONOTRON freezes action picture until intentionally erased.

TYPOTRON

The TYPOTRON is the first commercially available storage tube for displaying printed data rapidly. A choice of 63 characters is available for the presentation of data in words, numbers or symbols. As a high-speed digital read-out device, the TYPOTRON writes characters 1/8 inch in size at speeds of at least 25,000 characters per second. The written information remains visible indefinitely without fading or blooming, until intentionally erased. This feature makes TYPOTRON an ideal read-out device in many digital computer applications.

Photo: Presentation of all available characters.

HUGHES PRODUCTS

A DIVISION OF THE HUGHES AIRCRAFT COMPANY

ELECTRON TUBES

Our applications engineers invite your inquiries regarding specific uses of these tubes. For further information and descriptive literature please write to:

HUGHES PRODUCTS • ELECTRON TUBES
International Airport Station
Los Angeles 45, California

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For more information circle **33** on inquiry card.

MOELLER MARINE INSTRUMENTS

SALINOMETER SETS

NO. 1693

No. 1691

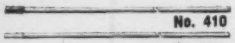
HEEL INDICATOR

No. 458

TRIM INDICATOR

No. 455

SOUNDING TUBES



No. 410

No. 420

FATHOM RULES

SOUNDING SHEATH

No. 440

SHIP CLINOMETER

No. 460

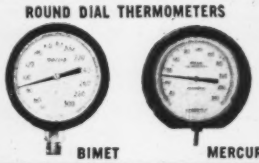
SOUNDING LEAD RODS

No. 450

RECORDERS

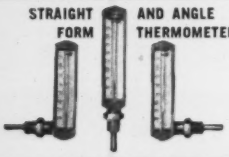
No. 6000

ROUND DIAL THERMOMETERS



BIMET MERCURY

STRAIGHT AND ANGLE FORM THERMOMETERS



METAL SALINOMETER HYDROMETER

No. 1690

METAL LOAD LINE HYDROMETER

No. 1695

THE ACME OF GUARANTEED ACCURACY AND DEPENDABILITY

On deck, and in cabin, or engine room to indicate temperature readings, or to take soundings — whether to measure fathoms, or determine trim and heel, Moeller Marine Instruments have set the standard of accuracy for dependability in the Marine field for more than half a century.

MOELLER INSTRUMENT COMPANY 132nd ST. and 89th AVE. RICHMOND HILL 18, N. Y.

Representatives in Principal Cities

Gentlemen: Without obligation, please send me Moeller Bulletin, "Especially for ships."

NAME .....

FIRM .....

ADDRESS .....

CITY..... ZONE..... STATE.....

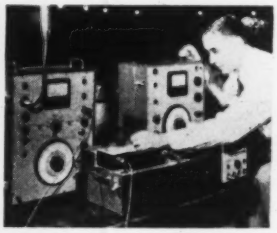
For more information circle **34** on inquiry card.

NEWS —CONTINUED

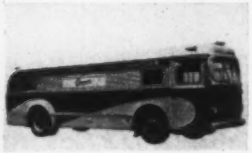
Machine for research computations in geophysics, solid state physics, electromagnetic radiation, optical components, navigation and sound physics.

LOGISTICS RESEARCH has installed an ALWAC electronic digital computer at Adalia Computations Ltd., Montreal, Canada, for use by Canadian Universities, business and industrial firms.

BRUSH ELECTRONICS CO. equipment—including an audio frequency spectrometer, highspeed level recorder, beat frequency oscillator with a warble tone attachment, condenser microphone and automatic reverberation time switch—has been installed in Cleveland Public Auditorium to study the problem of the hall's poor acoustics.



♦ Brush equipment analyzes auditorium acoustics



Cramer traveling exhibit

CRAMER CONTROLS CORP. has launched a traveling timer-display coach which will visit major industrial plants throughout the country to promote familiarity with timing applications and techniques.

Moro M. Borden

Moro M. Borden, 79, Engineering Consultant of the Simplex Valve and Meter Co., died at his home in Collingswood, N. J. November 16th.

Orville C. Gatti

Orville C. Gatti, president of Aurele M. Gatti, Inc., died October 27th during an operation. Born in Coventry, England, Mr. Gatti was the seventh generation in a family of jewel bearing makers.

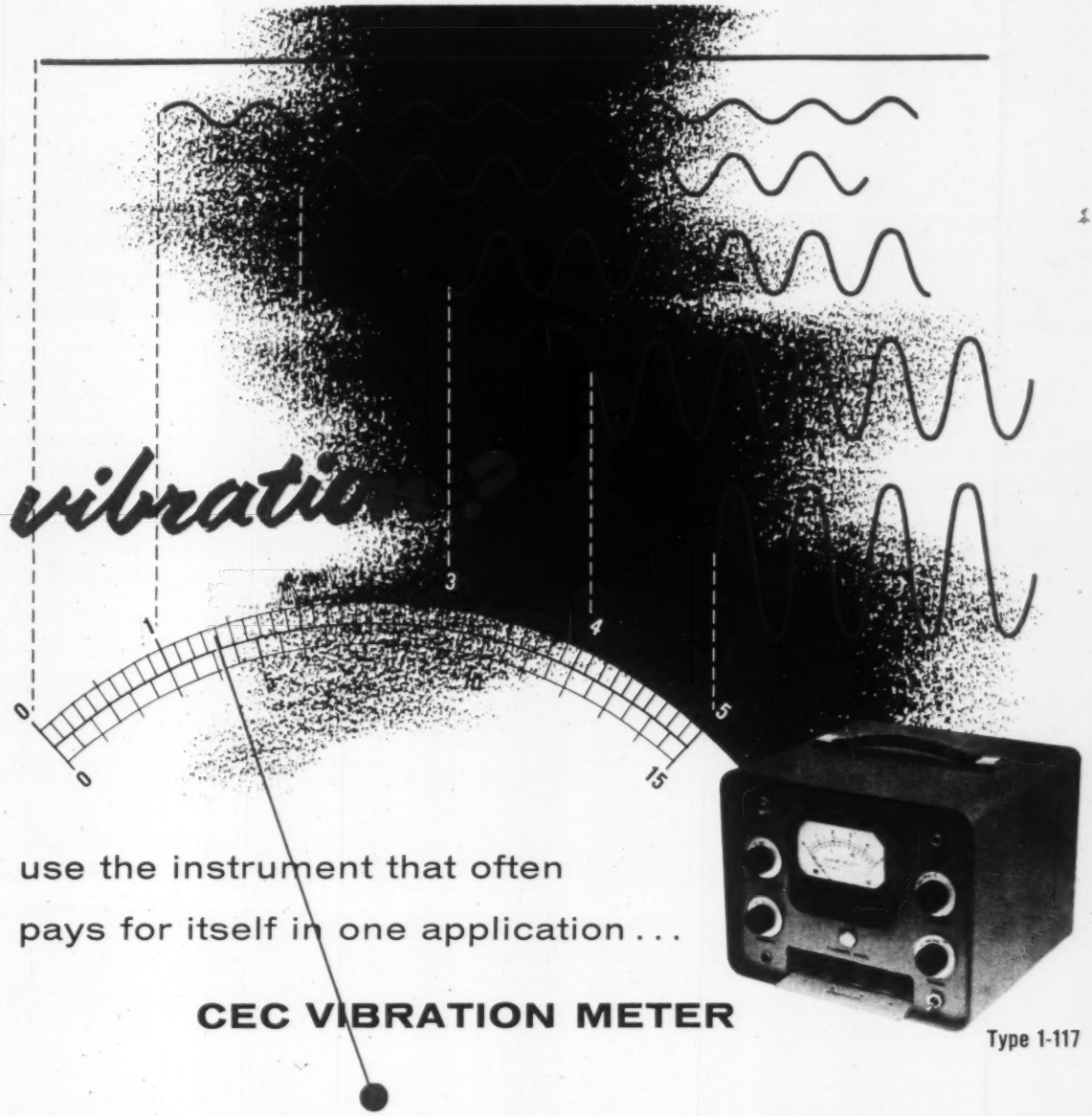
Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

Dec. 20, 1956

OVER-THE-COUNTER	BID	ASKED
Aerovox Corp.	4	4 3/4
Aircraft Radio Corp.	18	19
Argus Corp.	17	17 3/4
Barry Controls, Inc.	8	9 1/2
Bitel-McCullough Co.	34	35 1/2
Electronic Associates, Inc.	55	58
Elox Corp. of Michigan "A"	9 1/2	10 1/4
Elox Corp. of Michigan "B"	9 1/2	10
Erie Resistor Corp.	20	21 3/4
G. M. Giannini	11 7/8	13
I-T-E Circuit Breaker	37 1/4	38 1/4
Liquidometer Corp.	8	9
P. R. Mallory & Co., Inc.	42 1/4	43 1/4
W. L. Maxson Corp.	6 1/4	6 3/4
Penn Controls, Inc.	17	19
Speer Carbon Co.	30 1/4	31 1/4
Sprague Electric Co.	31 3/4	33
Taylor Instrument Co.	69 1/2	71 1/2
Telecomputing Corp.	3 7/8	4 1/2
Topp Industries, Inc.	8 5/8	9 1/8
Varian Associates	15	16 1/2
Vitro Corp. of America	21 1/2	22 1/4

Continued on page 46



use the instrument that often
pays for itself in one application . . .

CEC VIBRATION METER

Type 1-117

When control of vibration is critical, CEC's 1-117 Vibration Meter is one of the best investments your company can make. Extremely versatile, accurate and rugged, the portable 1-117 is recommended for any vibration analysis where 115 volt, 50/60/400-cycle a-c is available.

Case histories prove this quality instrument quickly paid for itself many times over in laboratories and jet-engine production and overhaul facilities . . . more than doubled machine tool life by pinpointing vibration amplitudes of less than 0.0001".

PROVIDES DIRECT READINGS of average velocity and either linear or torsional peak-to-peak displacement on a large, easy-to-read meter. Output may also be connected to an oscilloscope or oscillograph for more detailed wave-form study.

FEATURES 4 INPUT CHANNELS with individually adjustable sensitivity . . . interchangeable high-pass filters for low-frequency cut-off . . . highly stable amplifier. The 1-117 is also adaptable to rack mounting. The only external accessories needed are suitably matched, self-generating pickups.

For complete specifications, please write for Bulletin CEC 1538B-X15, or contact your nearby CEC field office.

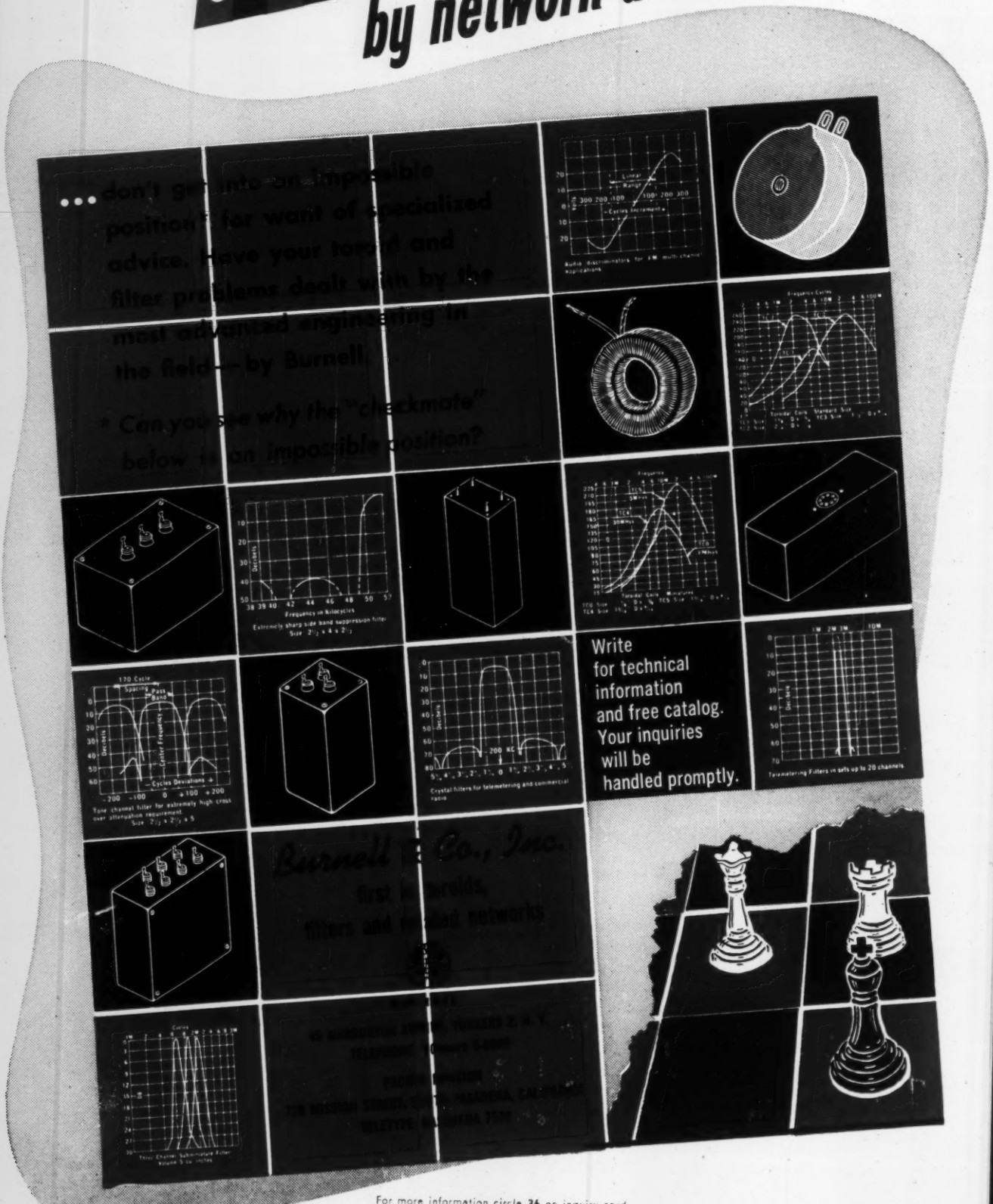
Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

NATIONWIDE COMPANY-OWNED SALES & SERVICE OFFICES

For more information circle **35** on inquiry card.

when you're checked by network difficulties...


...don't get into an impossible position for want of specialized advice. Have your toughest and most advanced engineering in the field—by Burnell.
Can you see why the "checkmate" below is an impossible position?
Write for technical information and free catalog. Your inquiries will be handled promptly.
Burnell & Co., Inc.

For more information circle **36** on inquiry card.

NEW DEPARTURE IS A HELPING HAND IN MINIATURIZATION

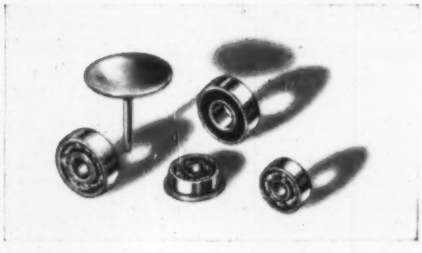
Volume is one of the big reasons why New Departure is the preferred source for miniature ball bearings.

And, of course, another big reason is ultra-precision! Despite their small size ($\frac{5}{32}$" to $\frac{1}{2}$" O.D.), New Departure miniature bearings are fully precision-ground, lapped, and honed to within tolerances of ABEC 5 or better.

Actually, precision starts with proper preparation of the stainless steel, where optimum metallurgical characteristics are assured by exacting heat treat equipment and processes. Finished bearings undergo rigorous testing and microscopic inspection on special equipment. Assembly and packaging take place in completely air-conditioned and pressurized areas to keep out contaminants.

However exacting your performance requirements, call on New Departure for miniature bearings unexcelled for precision, accuracy, and long life. New Departure, Division of General Motors, Bristol, Connecticut.

BALL BEARINGS MAKE GOOD PRODUCTS BETTER



SEE NEW DEPARTURE ON
"WIDE WIDE WORLD" SUNDAYS—NBC-TV

New Departure Division
General Motors Corporation
Bristol, Connecticut
Att. Dept. D

Gentlemen: Please send me free catalog on miniature bearings.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

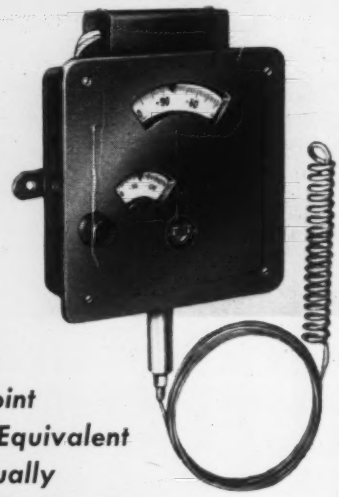
NEW DEPARTURE
BALL BEARINGS

GM GENERAL MOTORS

NOTHING ROLLS LIKE A BALL

For more information circle **37** on inquiry card.

REMOTE BULB, INDICATING TEMPERATURE CONTROL E32N



Type

E32N

Featuring Control Point Accuracy Equivalent to Individually Calibrated Instruments

The **UNITED ELECTRIC** Type E32N Temperature Control is a uniquely designed instrument that is used to control and indicate temperatures of gases, liquids or hot plates over wide ranges. This unit contains a 12-inch scale for easily read visual indications. It is possible to replace the thermal unit in the field without any loss of calibration accuracy.

Temperature Ranges	−150°F. to 150°F., 70°F. to 370°F., 100°F. to 650°F. Read temperature on continuous, 12-inch indicating scale that rotates against a fixed index pointer in a vertical and centered location.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
On-Off Differential	Approximately 1.0°F. or 2.0°F. dependent on model.
Adjustment	Calibrated dial rotated against a fixed index.
Calibration	Calibrating mechanism permits precise matching of scale to individual tolerance errors of thermal assemblies.
Compensation	Automatic compensation for ambient temperatures.

SEND FOR NEW Catalog 200 for full information on the E32N and other remote bulb temperature controls.

United Electric Controls COMPANY

81 SCHOOL STREET, WATERTOWN, MASS.

For more information circle **38** on inquiry card.

NEWS —CONTINUED

Stock Report continued from page 42

New York Stock Exchange:

Price Range for 1956 Thru Dec. 21

SECURITY	HIGH	LOW	AS OF DEC. 21, 1956
ACF Industries	67 7/8	55	58
Aeroquip Corp.	21 1/2	11 7/8	20 5/8
Allis Chalmers	37 1/4	30 1/8	33 1/8
American Chain & Cable	61 3/8	38 1/2	54 3/4
American Machine & Foundry	40 3/4	24 1/8	37 1/4
American Machine & Metals	45 3/4	35 1/8	40 3/4
American Optical	40 3/4	33 1/8	33 7/8
American Tel. & Tel.	187 1/8	165	168
Argus Camera	27 1/2	20 1/2	21
Beckman Instruments	40 1/2	25 1/8	38 1/4
Bell & Howell	48 1/4	28 1/4	48
Bendix Aviation	63	48 1/2	62
Boeing Airplane	65 3/8	45 3/8	63 5/8
Bullard	38 3/8	26 3/8	26 3/4
Bulova Watch	23	20 1/8	20 3/4
Burroughs	46 7/8	26 1/2	40
Carborundum	45 1/8	31 1/2	41 1/2
Cincinnati Milling Machine	55 1/4	37 1/4	50 1/8
Clevite	24 1/8	18	18 7/8
Columbia Broadcasting "A"	34 1/2	22 5/8	33 1/2
Consolidated Electronics	36 1/2	26 1/2	30 1/8
Cornell Dubilier	40 1/8	23	23 1/2
Corning Glass	87 1/2	50 1/4	59
Curtiss-Wright	49 3/4	26 3/4	47 1/4
Cutler Hammer	65	53	61
Daystrom	30 3/8	22	28
Dobeckmun	39 1/4	27	27 1/4
Douglas Aircraft	95 5/8	72 1/2	89 3/4
Eastman Kodak	100 3/4	75 3/4	87 7/8
Eaton Manufacturing	66	51 1/2	59 7/8
Electric Auto Lite	41 3/8	32 1/2	34 3/8
Elgin Watch	17 3/8	11 1/8	12 1/4
Food Machinery & Chemical	77	51	61 5/8
Gamewell	32 3/8	25 5/8	27 1/2
Garrett	54 1/2	38	53 1/8
General Dynamics	59 5/8	45 1/8	58 1/8
General Electric	65 1/2	52 3/4	61 1/4
General Instrument	10 1/8	6 1/2	6 5/8
General Mills	71 3/4	51	67
General Precision Equipment	53 1/2	34 1/2	40 1/2
General Railway Signal	32 1/4	29	32
General Telephone	46	38	40
General Time	34 5/8	29 1/4	30
General Tire	66 3/4	47 1/4	52 3/4
Goodyear	81 1/2	60	81 1/4
Hamilton Watch	27	19	23 5/8
Hoffman Electronics	25 3/8	18 5/8	19 1/8
International Business Machine	523	400	498 1/2
International Tel & Tel.	37 3/8	29 1/4	31
Lockheed Aircraft	58 7/8	43 1/4	56 3/4
Magnavox	41	31 1/2	36 1/2
Minneapolis Honeywell	90 1/2	58	84 5/8
Minnesota Mining & Mfg.	85 1/2	61 1/8	66 1/8
Motorola	51 3/4	37 1/2	40
National Acme	82	62	74 1/2
National Cash Register	59	34 1/8	49 7/8
North American Aviation	49 7/8	38 3/4	39 7/8
Northrop	29 1/8	21 1/4	25 1/8
Otis Elevator	50 3/4	33 1/4	44 1/2
Philco	36 1/2	16	17
Radio Corp. of America	50 3/8	33 7/8	35 1/2
Raytheon	19 1/2	13	17 1/2
Rheem Manufacturing	37 1/8	17 3/8	17 3/8
Robertshaw Fulton	28 3/8	21 1/2	25 3/4
Sangamo Electric	37 1/2	29 1/2	33 3/4
Sperry Rand	29 1/8	21 3/4	28 7/8
Square D	31 1/2	22 5/8	29 1/2
Standard Coil	12 3/4	6 1/2	6 5/8
L. S. Starrett	65 1/2	43 3/4	61 1/2
Stewart-Warner	39 1/2	30 1/4	33 3/4
Sylvania Electric	55 7/8	42	44 1/2
Telautograph	15 1/4	6 1/2	6 3/4
Texas Instruments	17	11 5/8	16 5/8
Thompson Products	80	48 5/8	75 1/2
Tung-Sol Electric	36 3/8	27	27 3/4
Underwood Corp.	44	20 7/8	25 7/8
Union Carbide & Carbon	133 7/8	103 1/4	115 1/2
Western Union	22 1/2	17 1/2	18 7/8
Westinghouse Air Brake	36 3/8	26 5/8	29
Westinghouse Electric	65 7/8	50 7/8	56 1/4
Worthington Corp.	60 1/2	41 1/8	58 1/4

American Stock Exchange:

Price Range for 1956 Dec. 21

	HIGH	LOW	AS OF DEC. 21, 1956 LAST
Air Associates	13 1/2	9	11 5/8
American Meter	41	31 1/2	33 1/4
Aro Equipment	24	17 1/4	17 3/4
Belock Instrument	19 3/8	12 1/2	13 7/8
Benrus Watch	10 3/8	7	7
Breeze Corp.	9 1/8	5 7/8	7
Clark Controller	37	16 1/4	31 1/4
Clarostat Mfg.	5	3 1/2	3 5/8
Clary Corp.	6 7/8	4 5/8	4 5/8
Consolidated Electrodynamics	34 1/2	21	33 3/8
Du Mont Labs.	10	4 3/8	4 5/8
Dynamics Corp. of America	8 3/8	5 5/8	5 5/8
Electronics Corp. of America	24 1/4	9 5/8	11 1/8
El-Tronics	9 7/8	3	3 5/8
Fairchild Camera & Instr.	25 7/8	19 1/2	20 1/4
Globe-Union	22	16 3/4	16 3/4
Haseltine Corp.	48	32	33 1/2
International Resistance	8 1/4	4 1/2	4 1/2
Lear, Inc.	10 1/4	7 3/8	7 5/8
Litton Industries, Inc.	29	23	28 1/2
National Research Corp.	29 3/4	16 1/4	17 1/4
Neptune Meter	36	28 3/8	31 1/2
New Haven Clock	2 1/2	5/16	3/8
Nordon-Ketay	14 7/8	7 3/8	8 3/8
Nuclear Corp.of America "A"	2 1/4	3/4	7/8
Pneumatic Scale	26 1/4	24	24 1/2 - 25 (1)
Reliance Electric	58 1/2	38 7/8	58 1/2
Servo Corp. of America	7 3/4	5	5 1/4
Servomechanisms	13 1/2	8 1/4	10 1/4
United Shoe Machinery	61 5/8	40 1/2	42 3/8
Wallace & Tiernan	31 1/2	19 1/2	29 1/4
Waltham Watch	3	1 1/4	1 1/2

(1) Bid - Asked price - no sale.

Askania Regulator Company NEWS

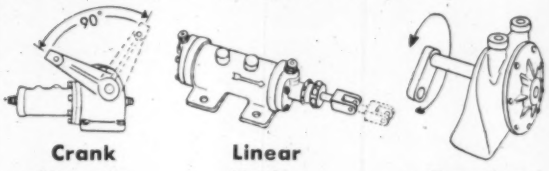
Automatic Controls for
FLOW, PRESSURE, RATIO, COMBUSTION, EDGE POSITION AND THICKNESS

ELECTROJET® PROVIDES ½ H.P. TO 40 H.P. HYDRAULIC OUTPUT FROM LOW LEVEL ELECTRICAL INPUT

FROM TRANSDUCERS:

FOR PRESSURE • FLOW • RATIO • WEIGHT OR FORCE • SPEED • POSITION • TEMPERATURE • THICKNESS

TO THESE FINAL CONTROL ACTIONS:



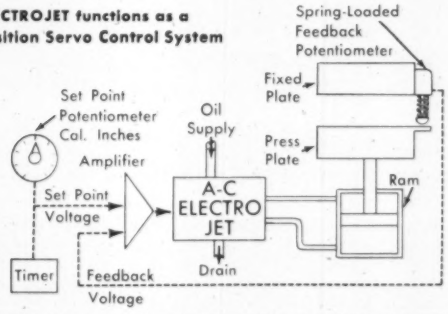
Crank Moment **Linear Motion** **Rotation**

Note the Unique Advantages

The ELECTROJET offers those particular advantages only hydraulic power can provide:

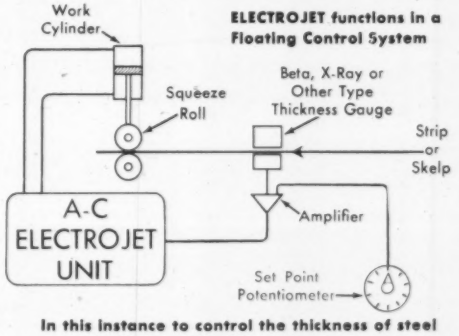
1. Low Maintenance—Self Lubricated Parts
2. Output Power to Fill Needs from Smallest to Largest Requirements
3. Wide Range of Operating Speeds
4. Low Time Constants
5. High Acceleration and Damping Power
6. Convenient Safety Interlocks

ELECTROJET functions as a Position Servo Control System



In this instance to control the thickness of the sheet felt being produced on an hydraulic press.

ELECTROJET functions in a Floating Control System



In this instance to control the thickness of steel strip in a Rolling Mill

STUDY THESE SPECIFICATIONS

A-C ELECTROJET

Reference winding (constant)	115v, 0.15 amp, 50-60 cps
Control winding (variable)	0-115v, 0-0.15 amp
Break-loose voltage	2v max.
Jet Pipe pressure	110-150 psi std, 400 psi max.
Jet Pipe flow (examples)	1.2 mm nozzles; 100 psi, 0.6 gpm 2.5 mm nozzle; 400 psi, 5.2 gpm
Booster pressure	2000 psi max.

D-C ELECTROJET

Maximum power input	6 watts
Coil resistance	5 ohms to 20,000 ohms
Break-loose power	20 microwatts
Hydraulic specifications	As for A-C Electrojet

Amplifiers for both A-C and D-C Electrojets are available to meet almost all requirements. However, in most applications the D-C Electrojet requires no amplifier.

Send for application bulletin No. 38.1

THE ASKANIA REGULATOR COMPANY APPLICATION BULLETIN NO. 38.1 contains
16 diagrams and illustrations to describe
1 available ELECTROJET types
2 applications and operation factors
3 types of Final Control elements, etc.

You'll want this bulletin for application... for study....for ready reference.

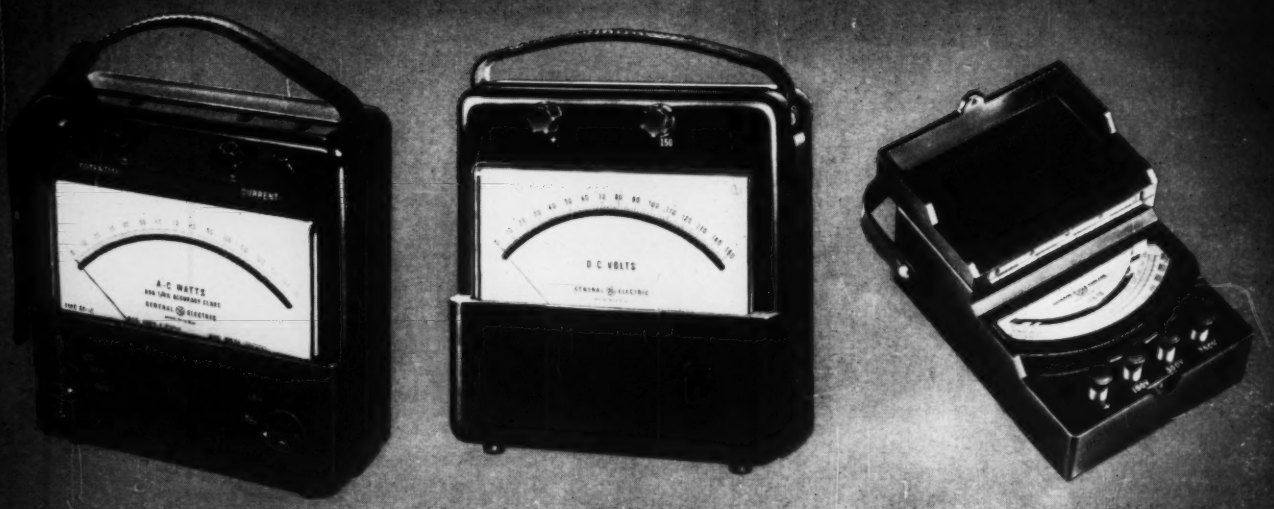
Write Askania Regulator Company, 268 E. Ontario Street, Chicago 11, Illinois

ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A SUBSIDIARY OF GPE

For more information circle **39** on inquiry card.

Instruments for Precision Measurement



AP-11	AP-12
For a-c measurements	For a-c/d-c measurements
Accuracy: ½ of 1% of full scale	**Accuracy:** ¼ of 1% of full scale

Scale length: 5.5 inches
Size: 7¾ x 7⅞ x 3¼
Weight: 5 lbs

DP-11	DP-12
For d-c measurements	For d-c measurements
Accuracy: ½ of 1% of full scale	**Accuracy:** ¼ of 1% of full scale

Scale length: 5.5 inches
Size: 7¾ x 7⅞ x 3¼
Weight: 5 lbs

AP-9	DP-9
For a-c measurements	For d-c measurements
Accuracy: ¾ of 1% of full scale	**Accuracy:** ½ of 1% of full scale

Scale length: 4.1 inches
Size: $2\frac{7}{16}$ x $6\frac{9}{16}$ x $4\frac{13}{16}$
Weight: 2½ lbs

Select the Portable Designed for Your Needs from General Electric's Expanded Line

From General Electric's newly expanded line, there is a portable instrument specifically designed for your testing job. Now, you can choose a portable testing instrument that combines G-E quality and dependability with your special requirements for accuracy, range, type of measurement, and price.

NEWEST ADDITIONS to the General Electric line are the Type AP-12 high-accuracy a-c/d-c portable ammeters, voltmeters, and wattmeters which match the Type DP-12 high-accuracy d-c portables. Both have an accuracy of ¼ of 1% of full scale.

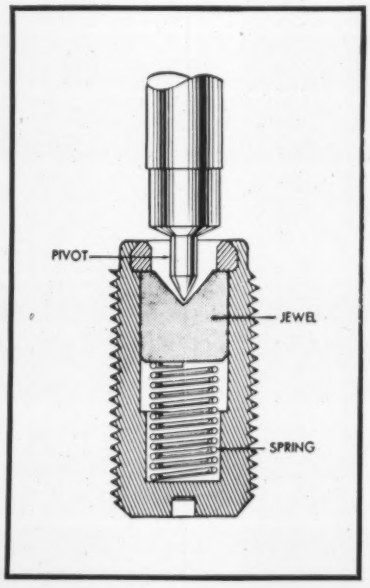
FOR A-C MEASUREMENTS where only ½ of 1% of full-scale accuracy is needed, you now can purchase G.E.'s new Type AP-11 portable. For d-c measurements with this accuracy, G.E. will continue to offer the Type DP-11 instrument. Rounding out the line are the low-cost Types AP-9 and DP-9.

LONG, EASY-READING SCALE, knife-edge pointer and mirror, spring-mounted bearings, improved shielding, and heavy-molded break-resistant Textolite* case are some of the G-E features which give you portable testing instruments with the rugged dependability demanded of plant test equipment and the performance characteristics generally associated only with higher priced laboratory standards.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or write for bulletins to: General Electric Co., Section 582-17, Schenectady 5, N.Y.

UNIQUE PIVOT-AND-BEARING DESIGN, shown at right, gives longer life to all G-E portable instruments. Spring-mounted jewels cushion the pressure on pivot points to minimize the danger of damaged pivots and jewel assemblies, a major maintenance problem with most portable instruments. →

*Reg. trade-mark General Electric Co.



GENERAL ELECTRIC

For more information circle 40 on inquiry card.

ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA announces that construction of new Santa Ana laboratory has begun.

New Plants and Mergers

FLEXONICS CORP. has acquired the **FLEX-O-TUBE DIV. OF MERIDAN CORP.** in exchange for cash and capital stock.

CONSOLIDATED ELECTRODYNAMICS CORP. has established district sales offices in Dallas, Houston, and San Diego.

FOXBORO CO. announces opening an instrument service shop in Atlanta, Ga. at 3232 Roswell Rd.

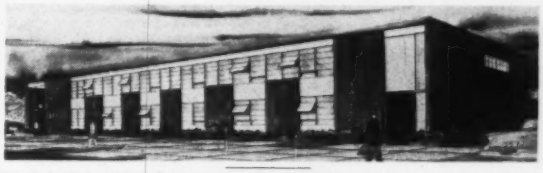
NORRIS-THERMADOR CORP. announces the acquisition of **NORTH AMERICAN INSTRUMENTS, INC.**

TEXAS INSTRUMENTS INC. announces entering into an agreement with Equitable Life Assurance Society to sell $10 million in notes due between 1959-1971; $4 million of the proceeds will be used to construct a building on Texas' 296-acre N. Central Expressway tract.

CAMBRIDGE THERMIONIC CORP. announces formation of a Canadian affiliate—**CAMBRIDGE THERMIONIC OF CANADA, LTD.**

BAILEY METER CO. announces acquisition of trade name, know-how, and other assets of **METROTYPE CORP.**

GERTSCH PRODUCTS, INC. announces start of construction of a new 30,000 sq. ft. plant at S. La Cienega Blvd., Los Angeles.



CHANCE VOUGHT AIRCRAFT has let a contract for construction of a $396,800 building to house a high-speed wind tunnel. Previous contracts let were to Chicago Bridge & Iron Co. for over $2 million for the wind tunnel proper and to Beckman Instruments for $165,000 for a data computation system to be installed in the tunnel.

PENN INSTRUMENTS DIV., BURGESS-MANNING CO. announces products formerly referred to as Penn Instruments will henceforth be known as Burgess-Manning Instruments.

ROBBINS

RAF DEHYDRATION

HI-LO FLOWS—HI-LO PRESSURES

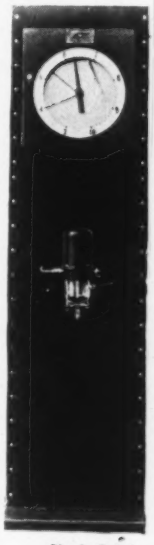
- New Leak Proof Design—Chambers and Cartridges.
- No gas bypassing Cartridge.
- "O" Ring Seal of Chambers and Cartridges.
- Mechanical Filter Elements easily removed for cleaning.
- No tools required to change cartridge or element.
- Automatic units for continuous and/or intermittent drying.
- For Portable, stationary and airborne installations.

Write for Bulletins

ROBBINS AVIATION

1735 W. Florence Ave., Los Angeles 47, Cal.

For more information circle **41** on inquiry card.



Single-Point pH Recorder (Strip Chart Assemblies also available)

CAMBRIDGE pH INDICATORS and RECORDERS

Labor saving—profit producing!

In addition to portable pH meters, Cambridge makes line-operated Direct Reading pH Indicators and Recorders for permanent installation. They are accurate, stable and assure continuous and trouble-free performance. Either the Recorder, Indicator or both, may be located at any reasonable distance from one or several sampling points. The Glass Electrodes are placed in vapor-tight housings of clog-free sampling chambers.

Send for Bulletin No. 910 T

CAMBRIDGE pH EQUIPMENT

CAMBRIDGE INSTRUMENT CO., INC.

3526 Grand Central Terminal, New York 17

PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

For more information circle **42** on inquiry card.

Precise

TEMPERATURE MEASUREMENTS

. . . with the Rubicon

MUELLER BRIDGE

A highly accurate and specialized form of the Wheatstone bridge designed expressly for precise resistance thermometry with three- or four-lead thermometers and for the measurement of other similar resistors within its range.

- Wide range: 0 to 141.1110 ohms in increments of 0.0001 ohm
- Unity ratio with provision for convenient checking and precise adjustment of ratio arms
- Built-in mercury commutator for lead resistance compensation
- Sub-panel switch construction
- Built-in plug and block assembly for conveniently checking ratio, bridge zero and thermometer resistance with no disturbance of external bridge connections

Described in Bulletin 100

. . . with the Rubicon

PORTABLE PRECISION POTENTIOMETER

A two-dial instrument of exceptional accuracy and sensitivity.

- High-sensitivity, sturdy, built-in Pointerlite galvanometer —permits balancing to within 2 microvolts in low resistance circuits
- Completely self-contained assembly—no external accessories except the thermocouple circuit
- Two ranges —0 to 16.1 and 0 to 161 millivolts—readable to within 2 and 20 microvolts respectively
- Sturdy, compact construction for long dependable service

Described in Bulletin 270

RUBICON COMPANY

Electrical Instrument Makers

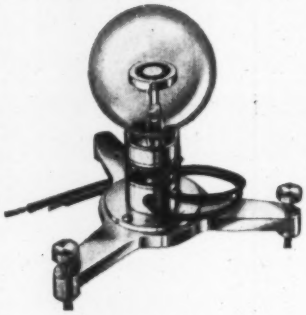
3755 Ridge Avenue Philadelphia 32, Pa.

For more information circle **43** on inquiry card.

EPLAB

PYRHELIOMETER

For the Measurement of SOLAR RADIATION



Eppley Pyrheliometers are used for solar radiation measurements at ninety-eight weather stations in the continental United States, Canada, Alaska, Greenland, Iceland, Caribbean Sea, and the Pacific Ocean. Sixty-two of these stations are under the direction of the United States Weather Bureau.

The Eppley Pyrheliometer was adopted as standard equipment by the Weather Bureau after considerable experimentation. It was found to be the best instrument so far tested by the Bureau.

Used in conjunction with a suitable recorder, the Eppley Pyrheliometer will provide an accurate and reliable record of total solar and sky radiation on a horizontal surface.

Bulletin No. 2 on Request

THE EPPLEY LABORATORY, INC.

Scientific Instruments

2 Sheffield Ave.

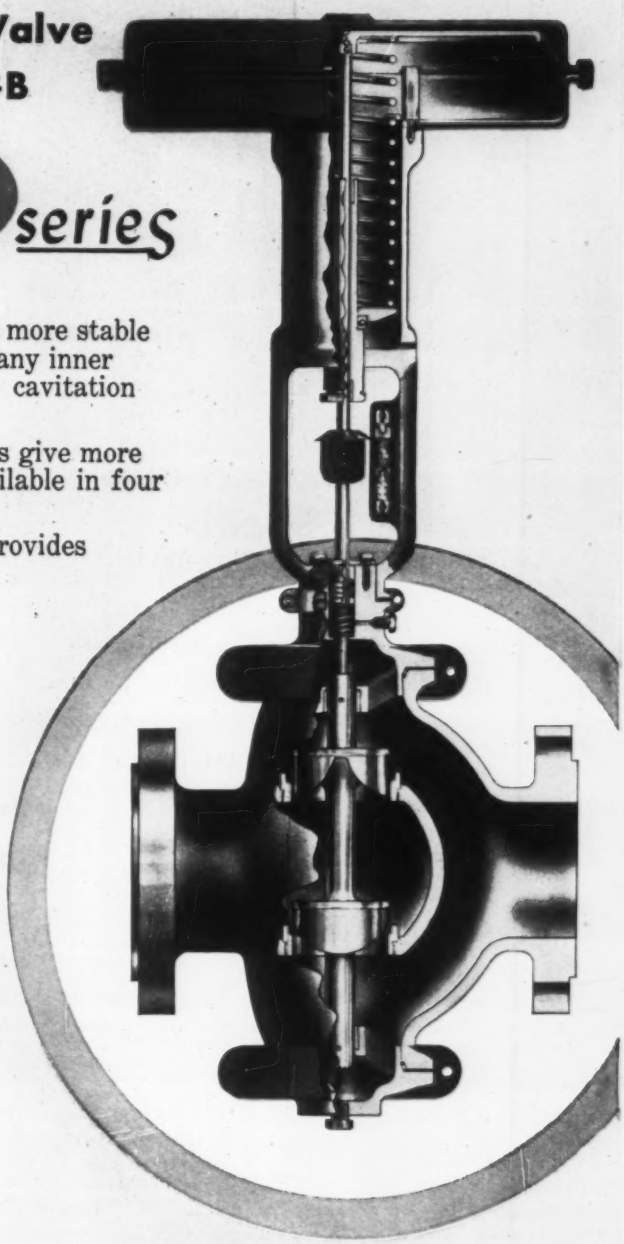
Newport, Rhode Island U. S. A.

For more information circle **166** on inquiry card.

TAKE A GOOD LOOK...

...At The Redesigned Valve Body Of The New BS&B

Super 70 *series*



NEW — Streamlined flow contours provide more stable flow at all rated differentials and any inner valve position. Turbulence and cavitation are minimized.

NEW — Accurately engineered inner valves give more exacting flow characteristics. Available in four types, top and bottom guided.

NEW — Patented all-metal float ring seal provides positive self-actuating closure... tightens with the application of pressure.

NEW — Forged clamp ring allows yoke orientation to any position. Requires only two bolts... eliminates annoyance of gasket replacements.

Super "70" Series valve bodies are available in three styles... single port, double port and split body for use in erosive or corrosive fluid service where easy removability of valve seat is desirable. All bodies can be reversed without change of parts or special tools. Split and bolted stem connector is strong, easily accessible and quickly assembled. Bolted stuffing box assembly with stainless steel follower includes spring-compressed Teflon as standard packing. Steel bodied valve dimensions are in accordance with ASA Standards B 16.5—1953.

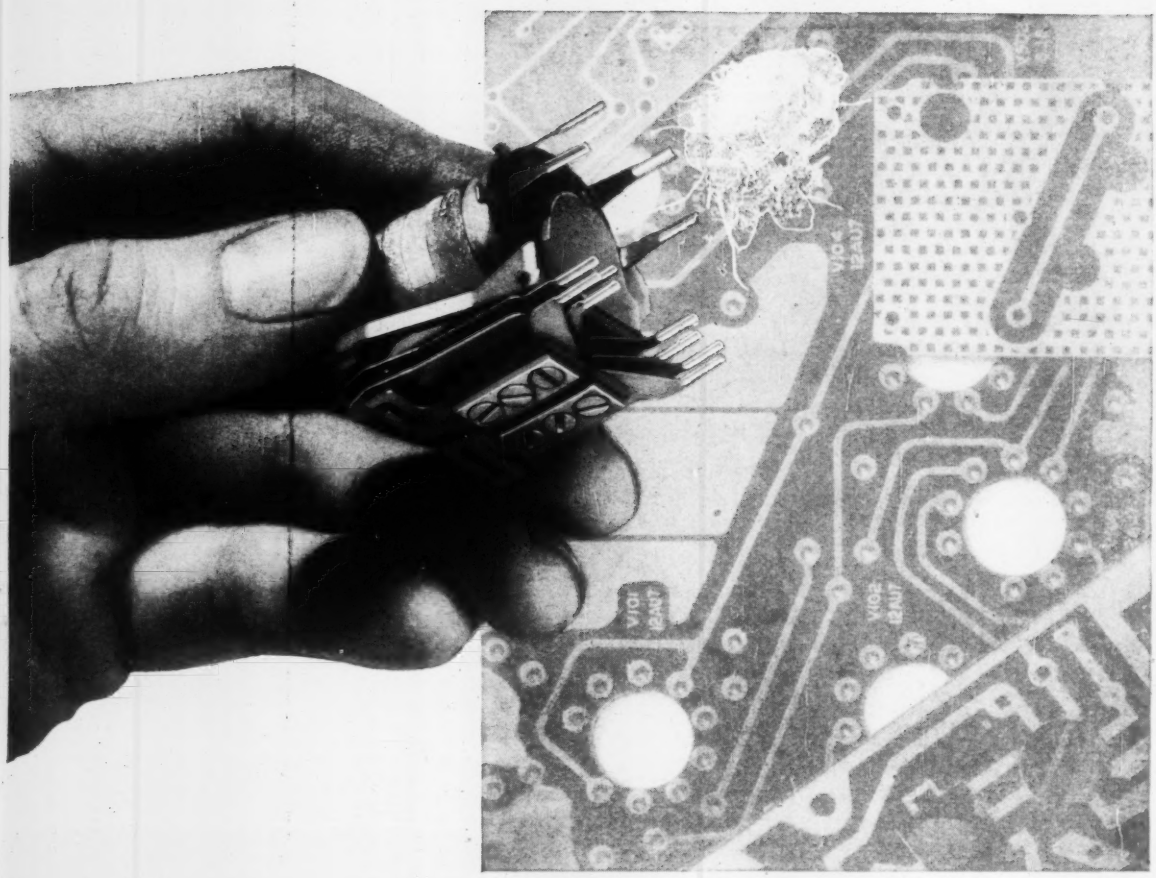
EFFICIENCY · OVER 60 YEARS · BS&B · RELIABILITY · ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

This advertisement highlights features of the Super "70" Series Valve Bodies only. Another will detail features of the Super "70" Series Topworks. Watch for it!

BLACK, SIVALLS & BRYSON, INC.

Controls Division, Dept. 4-V1

7500 East 12th Street — Kansas City 26, Missouri



NOW!

dependable relays for printed circuits

Maybe you, too, have been awaiting availability of a *good* relay for direct insertion into printed circuits. Now Automatic Electric can solve your problem with a miniature relay that is just right.

120 million operations, without a single readjustment or relubrication! That's what you get from this rugged, improved Series SQPC Relay, because it features a special *heavy-duty* bearing and bearing pin. Also a recess in the bearing plate retains an adequate supply of lubricant for long-term lubrication of the bearing pin.

Consider these additional advantages:

1. The sections of the terminals that insert into the printed circuit board are NOT brazed or welded into place, but are integral parts of the coil terminals and contact springs—thus preventing internal loss in conductivity or continuity.
2. Terminal design permits direct plug-in of the relay into a printed circuit board, ready to be secured in place with any acceptable soldering technique.

Usually the desired contact spring combination, or pile-up, is sufficiently large so that additional mounting (support) of the relay is not necessary.

SQPC Miniature Printed Circuit Relays are available with many different contact spring arrangements, and for a multitude of applications. Springs can be made of phosphor-bronze, "Bronco" metal, or other special-purpose materials, as required.

Of course the long life, heavy-duty features of the improved SQPC Relay can be had in the conventional type of plug-in relay, if regular sockets are preferred for use, whether in printed circuitry or other applications.

To get complete details, write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Illinois. *In Canada:* Automatic Electric (Canada) Ltd., Toronto. *Offices in principal cities.*

AUTOMATIC ELECTRIC

Originators of the dial telephone • Pioneers in automatic control

GENERAL TELEPHONE SYSTEM

For more information circle **45** on inquiry card.

People IN THE NEWS

AIRBORNE INSTRUMENTS LABORATORY announces appointment of *Arthur V. Loughren* as vice president of the new research division.

A. V. Loughren
Airborne

Norman Grieser
Underwood

UNDERWOOD CORP. announces appointment of *Norman Grieser* as sales manager of the Electronic Computer Div.

P. R. MALLORY & CO., INC. announces appointment of *Dr. C. H. Moore* as executive director of corporate research and development.

REMINGTON RAND UNIVAC DIV., SPERRY RAND CORP. announces appointment of *James A. Finigan, Jr.*, as general sales manager for electronic sales.

THE SWARTWOUT CO. announces appointment of *R. L. Broderick* as Houston District Manager for the Autronic Process Controls Division.

SERVOMECHANISMS, INC. announces election of *Francis Marion Banks*, president and general manager of the Southern California Gas Co., to the Board of Directors. Recent appointments include *Robert S. Miller* as works manager of the Western Div., and *Thomas R. Cataldo* as sales manager of the Mechatrol Div.

GENERAL PRECISION LABORATORY announces six executive promotions including *Dr. Raymond L. Garman* as executive vice president and technical director, *James W. Murray* as executive vice president and general manager, *Richard W. Lee* and *William J. Tull* as vice presidents, *William P. Hilliard* as president of Pleasantville Instrument Corp., and *Raymond G. Johnson* as assistant treasurer.

R. L. Garman
General Precision

H. C. Sager
Stromberg-Carlson

STROMBERG-CARLSON DIV., GENERAL DYNAMICS CORP., announces appointment of *Harold C. Sager* as manager of automation sales department.

FILTORS, INC. announces appointment of *C. G. Barker* as sales manager.

HANKISON
Condensifilters

When you specify Hankison Condensifilters, your pneumatic instruments and controls receive POSITIVE PROTECTION from:
Moisture, *entrained and vaporized*
Oil, *entrained and vaporized*
Dirt — Scale — Rust
Hankison Condensifilters combine a water-cooled condenser and a disposable filter cartridge in one compact, sturdy unit. Write today for Bulletin M-7155R.

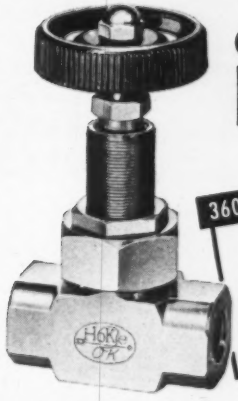
MODEL	CAPACITY
M-30	30 SCFM @ 100 PSIG
M-100	100 SCFM @ 100 PSIG

Condensifilters are ASME coded. HC-10

HANKISON CORPORATION
Biltmore Building • Pittsburgh 16, Pa.

For more information circle **46** on inquiry card.

HOKE announces
10 valves in 1



360 SERIES
High Pressure UNION BONNET GLOBE VALVE

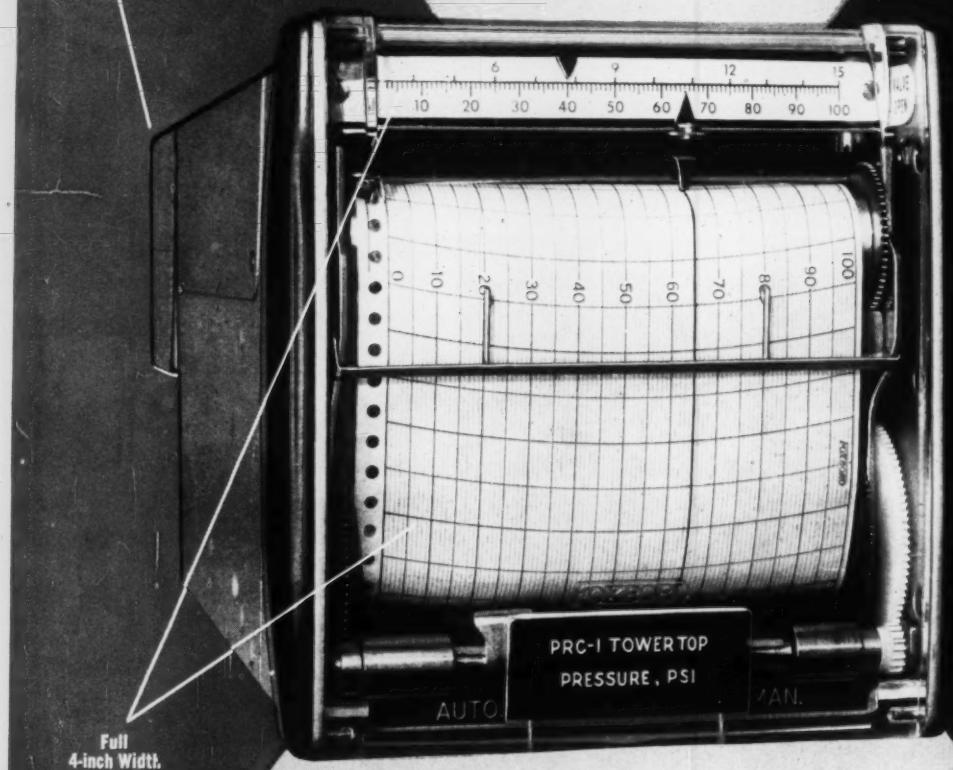
For conditions ranging from 3000 psi to low vacuums, or distilled water to corrosive fluids. Series consists of four basic stainless steel bar stock valves... O-ring or Teflon packing with flat Teflon disc or vee point non-rotating, replaceable stem plug... plus six body styles. All parts interchangeable as well as replaceable. Choice of ¼", ⅜" or ½" pipe sizes or Swagelock tube fittings. Panel mounting, too. **Get the facts about this "10 in 1" valve. Write us today.**

HOKE
HOKE INCORPORATED
Fluid Control Specialists
231 S. Dean Street
Englewood, N. J.

For more information circle **47** on inquiry card.

NOW...

compactness with nothing sacrificed!



Models to Meet All Your Specifications

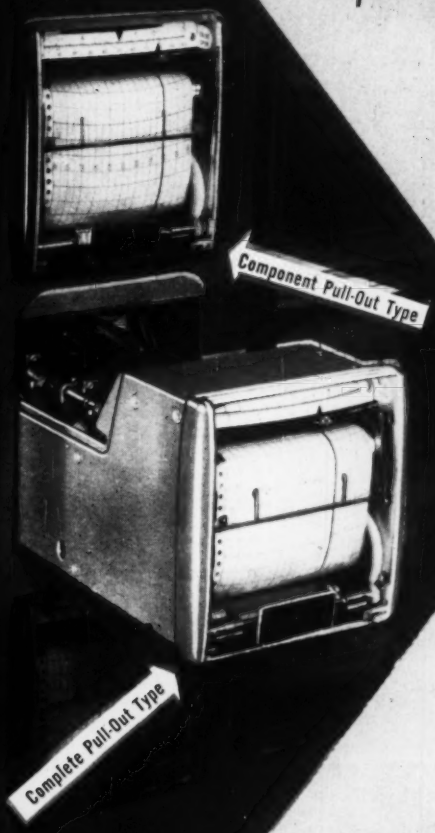
In all the following CONSOTROL instruments, recorder and indicator units can be easily converted in field.

- Recording Control Station with automatic/manual transfer
- Recording Control Station with manual loading only
- Recorder — single or two pen
- Indicating Control Station with automatic/manual transfer
- Indicating Control Station with manual loading only
- Indicator — single or two pointer

For more information circle **48** on inquiry card.

CONSOTROL

small-case panel instruments



Here's the "tops" in centralized recording and control efficiency! CONSOTROL Instruments require the minimum of valuable panel space, yet provide unsurpassed operator convenience, visual accuracy, and ease of maintenance . . . maintain the highest standards of precision and dependability. For example: the simple CONSOTROL method of switching from automatic to manual control requires no memory or extra operations . . . never "bumps" the process. All CONSOTROL charts and scales are full 4-inch width for greatest visibility . . . highest accuracy. When it comes to servicing, there's plenty of "finger room" . . . all parts are uncrowded and easily removable. And just compare inking requirements with other designs. CONSOTROL needs ink filling only once or twice a year! These are only a few of CONSOTROL's advanced design features — available in both fixed-mounting and full pull-out type instruments. Get the complete story. Write for Bulletin 13-18. The Foxboro Company, 461 Norfolk Street, Foxboro, Mass., U.S.A.

FOXBORO

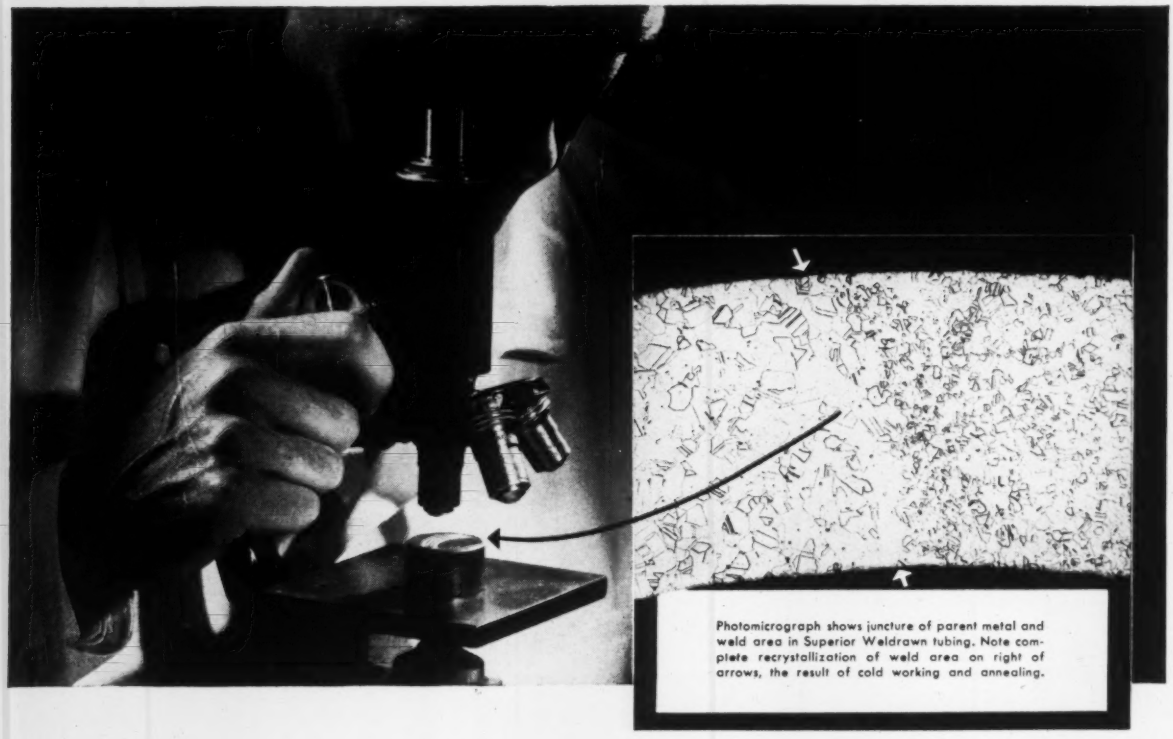
REG. U. S. PAT. OFF.

Consotrol Process Control

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

For more information circle **48** on inquiry card.

Weldrawn® Tubing *by* Superior



Photomicrograph shows juncture of parent metal and weld area in Superior Weldrawn tubing. Note complete recrystallization of weld area on right of arrows, the result of cold working and annealing.

So perfect the bead actually vanishes!

Here's how to cut tubing costs up to 50%

Specify Superior Weldrawn. You get quality approaching that of seamless, at savings as high as 50%! Unlike other welded tubing, Weldrawn is offered in *any* of the intermediate sizes—made possible because of the redrawing after welding.

"Weldrawn" Means—

This is a tubing far superior to ordinary welded tubing for many applications requiring forming, machining and corrosion resistance. After welding, it undergoes alternate cold drawing and annealing.

The weld area recrystallizes (see photo above), acquiring mechanical properties equivalent to those of the parent metal. The bead actually vanishes!

Costs Are Low

Weldrawn tubing is produced in 18 different analyses, in a wide variety of sizes. Cost savings are 10 to 20%. In certain materials you save up to 50%!

Quality Is High

In Weldrawn you get tubing with highly uniform mechanical properties throughout, and clean, smooth, bright ID and OD surfaces. Because no filler or flux is used during welding, the corrosion resistance of the weld area is equal to that of the parent metal. And by repeated redrawing and annealing after welding, any possible faults or defects in the weld are eliminated.

Specify Superior

In addition to Weldrawn tubing, we also offer a wide variety of analyses and sizes in Seamless grade. So for the finest in small tubing, always specify Superior.

Whatever your problems in small tubing, Superior can help you. For additional information on Weldrawn, write for Data Memorandum No. 2. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses available in .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

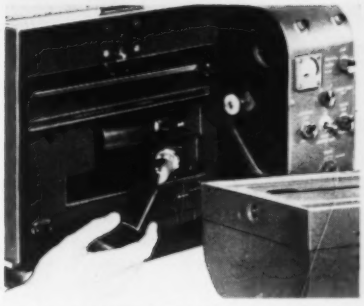
For more information circle **49** on inquiry card.

HERE'S HOW GENERAL ELECTRIC'S

New PM-20 Oscillograph Helps Reduce Costs

NEW EASY-ACCESS DESIGN, MANY CONVENIENCE FEATURES MAKE OPERATION AND MAINTENANCE EASIER, SAVE TIME AND MONEY

EASY-ACCESS DESIGN permits reaching all parts easily through hinged doors. For complete access, simply turn 3 fasteners and entire cover may be quickly removed.



SEPARATE VIEWING LAMP permits viewing without disturbing the recording lamp adjustment. Both lamp holders swing out for easy lamp removal and replacement.

NEW G-E FEATURES SAVE TIME

General Electric's new general-purpose oscillograph, the PM-20, is uniquely designed for easier, time-saving operation and convenient maintenance.

UNIQUE 71-GALVANOMETER CAPACITY in two banks gives you new versatility in measuring and recording many variables simultaneously. A wide range of frequencies—from d.c. to 6000 cps—can be recorded at speeds from 0.8 to 100 inches per second with the new oscillograph.

ONLY TWO IDLER GEARS TO CHANGE for entire speed range, and both are always in use, eliminating storage and the chance of loss. No tools are needed for changing idler gears to get new ranges.

MAGNETIC SPOOLS in the record holder reduce loading time. No fumbling—the spools automatically position themselves correctly in the record holder.

AUTOMATIC SHUTTER on record holder closes as the record holder is removed, preventing fogging of records.

AUTOMATIC RECORD NUMBERING, timing lines, the trace interruption for identification, and automatic record-length control are additional features which give you easy, reliable operation.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or write for Bulletin GEA-6348 to Section 585-36, General Electric Company, Schenectady 5, New York.

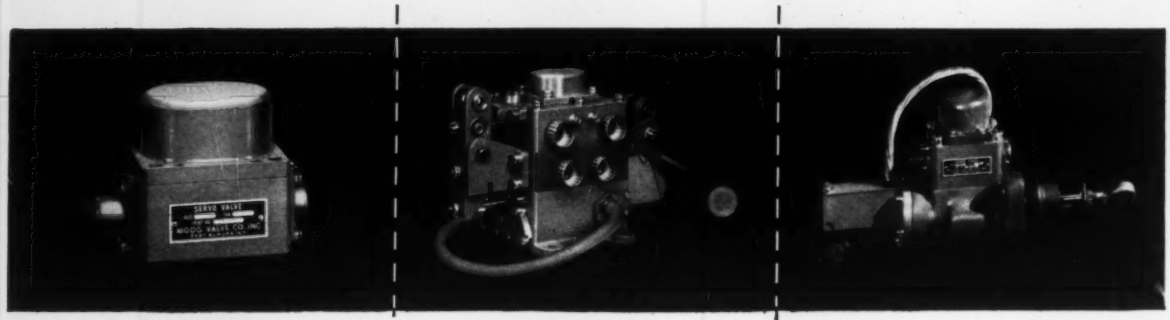
GENERAL ELECTRIC

For more information circle **50** on inquiry card.

From MOOG . . . **Advanced Electro-Hydraulic Servo Components**

Moog is the industry's leading producer of electro-hydraulic servo valves. This leadership has been achieved by advanced valve design resulting in high performance, high quality, reliability and efficient manufacture. The same creative approach applied to industry's newer problems has resulted in the introduction of Moog Dual Input and Servo Actuator units.

These recent achievements in the creation of advanced custom designed electro-hydraulic servo components are evidence of Moog's continuing progress.



SERVO VALVE

• These proportional "dry motor" electro-hydraulic servo valves feature high dynamic response, sensitivity, linearity and reliability. Light-weight and compact, they are also available in custom designed versions for special or advanced applications.

DUAL INPUT SERVO VALVE

• This new component provides for positioning of aircraft control surfaces by summing mechanical and electrical inputs without external use of mechanical linkages. Use of an entirely new concept offers improved performance, system simplification and saving of space and weight.

SERVO ACTUATOR UNIT

• Custom designed integrated assemblies include actuating cylinder, electro-hydraulic servo valve and feedback sensing device. In a closed loop, actuator displacement is a function of input signal.

TO THE ENGINEER IN A "HURRY"

Axiomatically, to get somewhere in a hurry, you get aboard something that moves pretty fast.

If your "somewhere" is a career in engineering, consider Moog. From three founders to five hundred employees within five years, we are today the industry's leading manufacturer of advanced electro-hydraulic servo components. Our engineers made this possible by continuous pioneering of the new and successful developments in the field. As our rapid expansion continues, we have many openings at all levels for qualified personnel.

Best time to get aboard is now.

MOOG

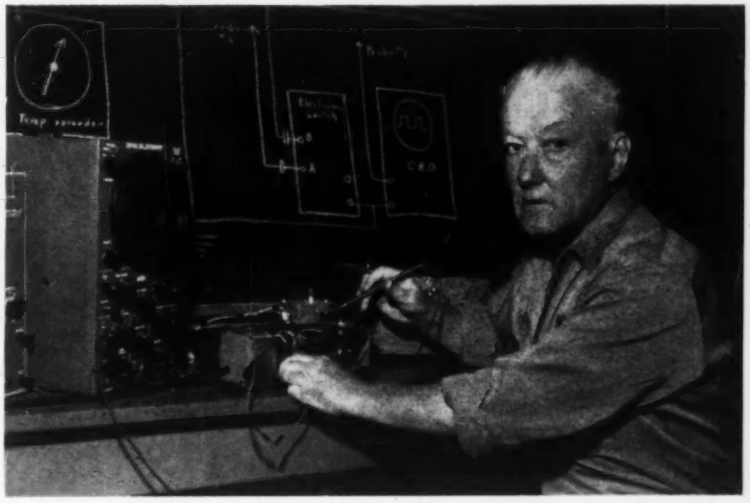
MOOG VALVE CO., INC. PRONER AIRPORT, EAST AURORA, NEW YORK

Research Laboratory, Paramus, New Jersey

For more information circle **51** on inquiry card.

SIGNIFICANCE

Monsanto is a big name in chemicals and plastics, and James J. Murray has been foreman of the instrument department at Monsanto Chemical Company's Everett plant since 1941. He has established training courses for department personnel, developed new testing procedures, procured modern testing equipment, improved shop facilities, and earned plantwide adoption of preventive maintenance programs. This month, we are pleased to acknowledge Jim Murray's important position in our field. His instrument department is shown on pages 30-31 of this issue.



JAMES J. MURRAY

Jim Murray is a native of Boston, Massachusetts. After graduating high-school, he became a Morse operator as a clerk with Western Union. He had previously learned radio work in his teens as a "ham."

Early in World War I, he enlisted in the U. S. Navy as Electrician 3rd class, and became 2nd and then 1st class with ratings of Electrician, Landwire Morse, and Radio Operator.

After his discharge from the Navy he worked for electrical contractors, specializing in trouble-shooting of electrical faults. In 1937 he joined the Monsanto Everett Plant as 1st class electrician. He transferred to the Instrument Shop in 1941 and has continued in instrument work ever since.

He fortified his practical knowledge with courses at M.I.T. (Lowell Institute) in Electrical Engineering, Electronics, Radio, and Industrial Chemistry. He also studied Industrial Electronics, Industrial Instrumentation and Process Control, and Radio Television at Massachusetts University Extension. All this excellent practical and academic background prepared him for the major development job that confronted him at the Monsanto Everett Plant.

The Instrument Shop in 1941 was a small room, about 8′ x 12′, and employed two instrument men (Jim and one helper). As instrumentation increased, he had to rapidly expand his shop and take on more men. His present shop is the third expansion; he now has nine instrument mechanics (see pages 30 and 31). These men were picked from plant personnel by a committee consisting of two men appointed by the union and two men representing the company. They were chosen on the basis of past work experience, education, aptitude, etc. None had had any previous experience in instrumentation. As Jim says, "My job was to train these men and keep the plant running too! Quite a chore, believe me."

It soon became evident that training by the "take apart, put together" method was not adequate. Instrument design and complexity was changing rapidly and obsoleting techniques almost as soon as they were learned. Furthermore, the knowledge acquired by this method was of little use for trouble-shooting faults.

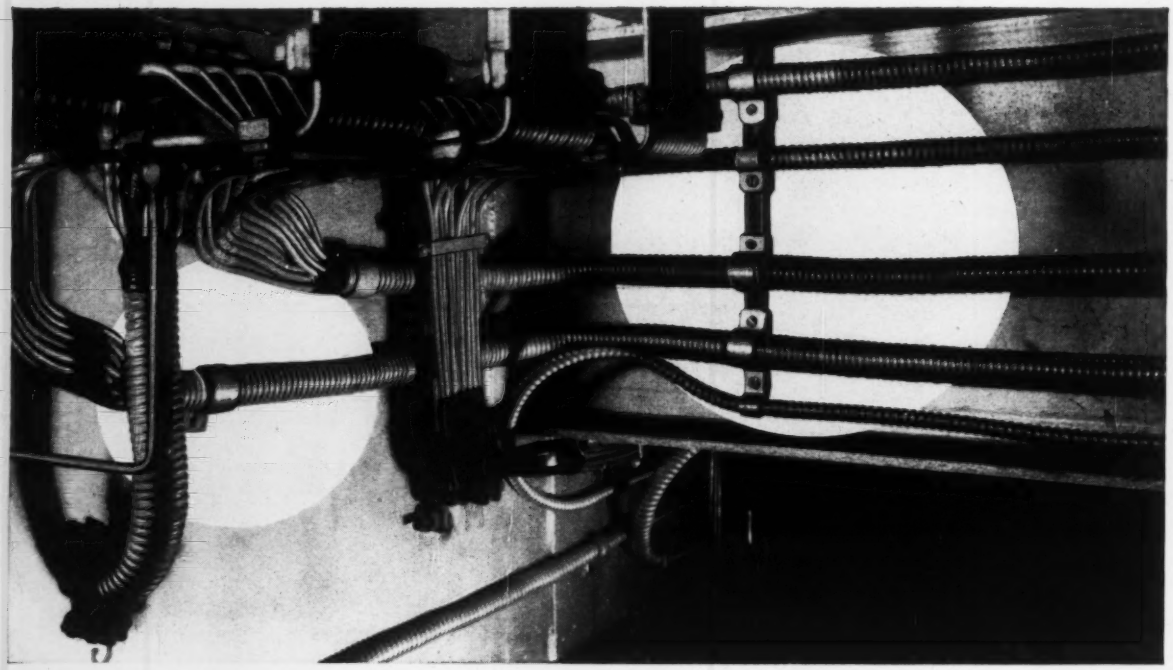
Thus his training program was slanted to heavy emphasis on principles, in the belief that men who understand the fundamental theory underlying the operation of industrial instruments and control can handle changing designs and the many different methods of measurement and control used by the various manufacturers. Also, this knowledge is a must to a good trouble-shooter. He has found that a man who understands his job will be more interested and enthusiastic about his work.

When asked about the trends at Monsanto Jim told us, "The trend in our plant is toward miniaturization. The many variables to be measured and controlled are transduced at the source to a pneumatic 3-to-15 psig signal and transmitted to the instrument room. This affords us a flexibility of control and maintenance heretofore unobtainable. Perhaps the outstanding advantage of the miniature is that it enables the operator to see the operation of an entire unit at a glance, thus correlating all the readings in his mind, instead of walking the length of a long instrument board and forgetting at one end the values he observed at the other end.

"I believe that the long range trend will be toward increased use of electrical transmission and control. With the electrical system we can look forward to the elimination of the problem of maintaining a clean, dry, air supply."

At present Jim is working on a method of making a simple routine procedure for locating and repairing trouble in an electronic amplifier. Various plug-in harnesses quickly

(*Continued on page* 61)



DIRECT SAVINGS of $5 to $6/foot

WITH BAILEY *ARMORTUBE* CABLE

Here are the cost facts.

A chemical plant bought only 530 feet of 4-tube Bailey ARMORTUBE Cable and installed it at a saving of $3,000 over the cost of four single tubes.

An electric utility bought $14,068 worth of ARMORTUBE Cable . . . saved $60,000 on installation.

Another chemical plant bought ARMORTUBE Cable costing $1,345. The saving on installation compared to single tubes amounted to $14,000.

Reports such as these are common from users of tubing for pneumatic instrument and control lines. They state it costs about $2.00 a foot to install a single tube. It costs the same $2.00 a foot to install Bailey ARMORTUBE Cable.

Here's why the savings.

ARMORTUBE Cable consists of 1 to 19 copper or aluminum tubes in a single armored cable. You string *one* line. You buy *one* set of standard pipe supports or conduit clips. Installation costs are reduced tremendously. Time is saved, tubes are protected, and installation looks neat.

Cost-saving Bailey ARMORTUBE Cable is offered in a full family of sizes and types . . . aluminum or copper tubing . . . ¼, ⅜, ½-inch OD tubes . . . various bundles of 1 to 19 tubes. Tubing is protected with galvanized steel armor. Also available with thermoplastic sheath either under or over the steel.

Whether your next job is 100 or 100,000 feet, Bailey ARMORTUBE Cable can save you $5 to $6 per foot at installation. For more information and specifications ask for Product Specification and Price List G91-9.

G-37

Instruments and controls for power and process

BAILEY METER COMPANY

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BAILEY METERS

For more information circle **52** on inquiry card.

Biographies—CONT.

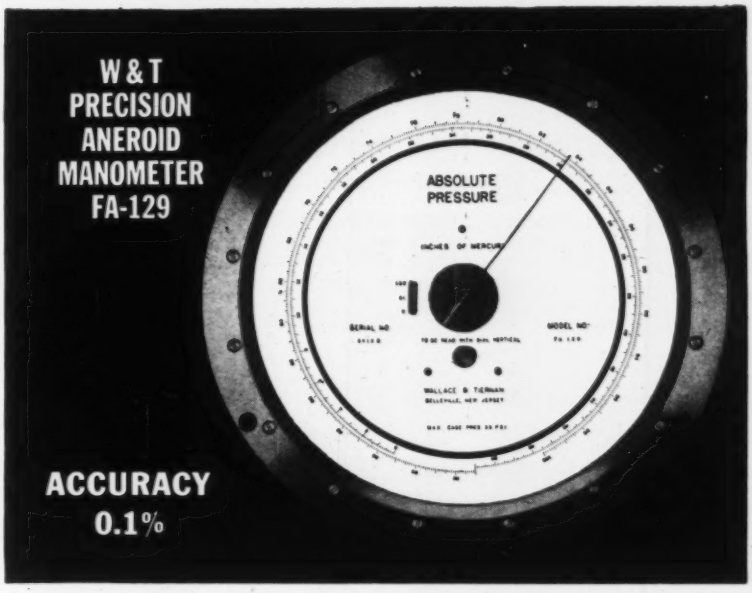
connect the many different types of amplifiers to a source of power and bring out connections for input and output signals, grounding, bonding, etc. A square wave is applied to the input and its progress through the amplifier traced with a cathode-ray oscilloscope. The distortion of the wave at various points in the amplifier indicates the source of trouble. As even a "good" amplifier shows some distortion, he photographs the wave at about ten points through the circuit of a good amplifier to give the operator an idea of what pattern is acceptable. Prints are made of each circuit and the test points (about 10) plainly marked.

The object of this procedure is to enable a man who has had little or no previous electronic experience to check through an amplifier and locate and correct faults.

As to *I&A*, Jim tells us that he has been reading it for many years, that he and other men get personal subscriptions, that the magazine circulates throughout his department, and that it is not only interesting but extremely helpful in the work of his department.

DON'T DROP THAT SCREW!
Hold it with an H.J.J. Screw-holding Driver
Sizes to handle from #0 to #¼" screws
The H.J.J. COMPANY
268 Marlow Drive • Oakland 5, California

For more information circle **53** on inquiry card.



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Other intermediate ranges available

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Write for Publication No. TP-15-A

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For more information circle **54** on inquiry card.

This pH Indicator "Prospects" for Oil!

To Gulf Research & Development, L&N's Stabilized pH Indicator is much more than a pH meter. Gulf researchers use it as a high impedance vacuum tube voltmeter and recorder preamplifier in studies like this measurement of potentials across porous plugs and membranes. Thus new light is shed on the significance of membrane potentials across natural shale bodies which contain the cation-exchanging clays so important in the electrical logging of oil wells.

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Quick Warm-Up—less than 60 seconds.

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Measuring Errors "Designed Out"—completely unaffected by zero drift, electrical pickup, a-c surges.

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Low Price—$275.75 for 120 v. model, $300.75 for 240 v. model, f.o.b. Phila. (subject to change without notice). Supplied with glass and reference electrodes, buffer, and potassium chloride solution.

Use No. 7664-A1 (120 v.) or 7666-A1 (240 v.) when ordering, or write Leeds & Northrup Co., 4955 Stenton Ave., Phila. 44, for details in Data Sheet E-96(2).

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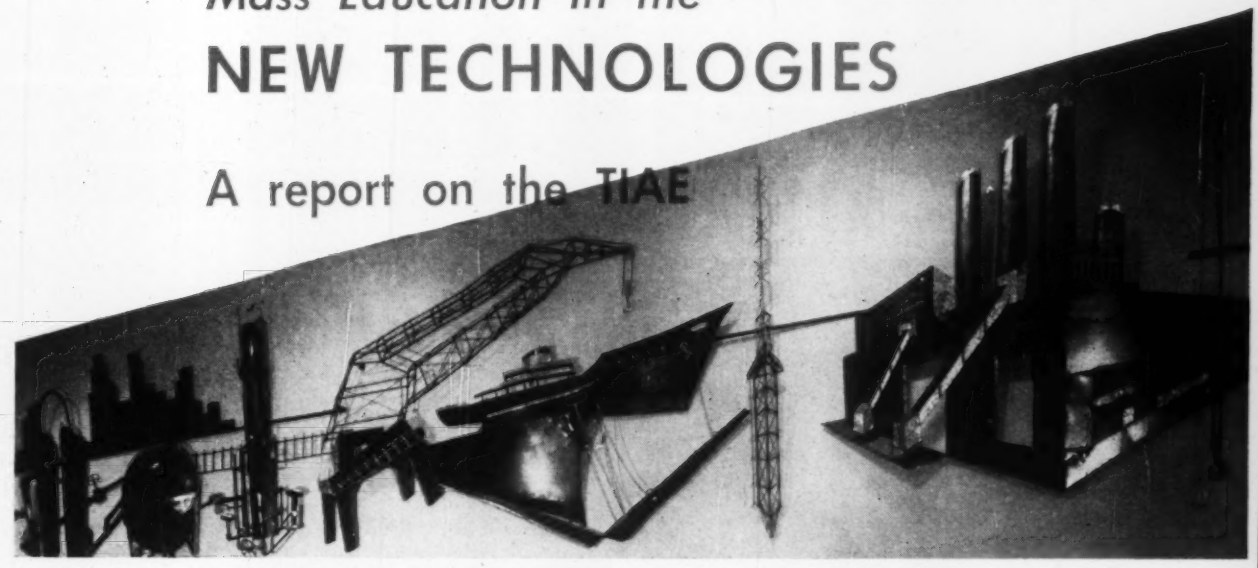
Mass Education in the
NEW TECHNOLOGIES
A report on the TIAE



Mural in lobby of the New York Trade Show Building provided an appropriate motif for the Third International Automation Exposition, New York, Nov. 26-30, 1956.

AUTOMATION WEEK in New York City (Nov. 26-30, 1956) is over, but its impact remains. Chief event of the week was the Third International Automation Exposition at the Trade Show Building, whose facilities were taxed to accommodate the 41,500 feet of exhibit space, 217 exhibits, and 15,104 registrants. For the third successive year, the show attracted a cross-section of American and overseas industrial and financial leaders of uniquely high calibre—plant managers, senior officers, executive assistants, and many others not normally attracted to a trade exhibit.

Foreign Attendance

Foreign registrants included 71 from West Germany, 46 from Canada, 28 from France, 22 from England, 15 from Sweden, and smaller numbers from Algeria, Argentina, Australia, Belgium, Brazil, Chile, Denmark, Finland, Greece, Holland, Israel (5), Italy, Japan (9), Mexico, Nicaragua, Norway, Pakistan, Portugal, Puerto Rico, Scotland, Spain, Switzerland (5), and Venezuela.

Office Automation Conference

Several of the foreign visitors also attended the two day Office Automation Conference at the New Yorker Hotel, which opened Automation Week. This conference, co-sponsored by the Third International Automation Exposition and Business School of Fordham University, attracted senior executives who studied the case histories of successful users of office automation. As a consequence, pressure developed for an International Automation congress to be held simultaneously with the Fourth International Automation Exposition, New York Coliseum, June 9-13, 1958.

Impact of the Clinics

Both the quantity and quality of the attendance made the TIAE a "success" in the conventional sense of the word. But other words must be found to describe the power and impact of the 210 clinic classes, at which nearly 1,000 registrants (972 to be precise) received 2-hour lecture-demonstration introductions to the mod-

Automatic machine tools attracted great interest. The "Digimatic" machine-tool control system is shown at left; the "Inductosyn" micro-positioning system of Farrand Controls is shown at right.

Senior executives who attended the 2-day Office Automation Conference examined 15 case histories of large-scale automatic data processing, including steel companies, life insurance companies, research institutes, airlines, banks, and various manufacturing firms.

The Soroban paper-tape puncher is the fastest in the world (240 code groups per second).

Automatic sorting and quality control was demonstrated by Barnes.

After the morning clinic classes, engineers examined the servo motors and components of Servomechanisms, Inc. Despite a seating capacity of 50, each of the 6 Servomechanisms, Inc. clinics was jammed.

ern technologies. This may well be one of the most important educational efforts of our times.

It is difficult to describe adequately the effectiveness of these clinic classes in introducing an engineer or plant manager to the new technological concepts which have been developed over the past ten years, but which are now ready for application, everywhere. By the scores and hundreds, industrial and commercial men found their eyes opened to techniques which have been developed while they were on the job. Yes, most had heard and read about the new techniques of analog simulation, digital computation, data logging, optimal process control, scaling and analysis of analog-type information, interlocked pneumatic circuits, electrohydraulic circuits, electronic multiplexing circuits, etc. But in class after class (each registrant received six 2-hour sessions), the men learned why the techniques had evolved as they had, and how the techniques are put to work by available equipment. The lecturers proved to be eloquent and skilled in developing the background, philosophy, techniques, applications and implications of their fields. Each lecture was given a final and hard-hitting conclusion by actual demonstrations of operating equipment. The result was powerful and effective mass education, both in depth and coverage.

Our readers who have not attended these clinic classes have gained some insight into the power of this education via the articles on the PACE and GEDA analog computers, on the G-15 and LGP-30 digital computers, and others presented at the Second International Automation Exposition (now available in Proceedings form in the *COMPUTER HANDBOOK*, 2nd Edition). Comparable

View of the open exhibit area in the afternoon. The mornings were devoted to the clinic classes.

work was done at the Third Automation Exposition on the Gerber curve analyzing equipment, the Computer Control Company digital units, the Burroughs E101 Computer, the Jerrold TV data-distribution systems, the Branson Ultrasonic techniques, the servomechanisms of Servomechanisms, Inc., and Servo Systems, etc., etc., We will bring this material to you in article form as rapidly as we can.

The pictures on the cover of this issue, and those within this editorial, illustrate the mass education that was the theme of the Third International Automation Exposition, and which is the theme of this editorial comment. A following comment—"Reflections of A Visitor to the TIAE"—eloquently portrays the impact of these new technologies on a practicing engineer.

Computer and Data Handling News

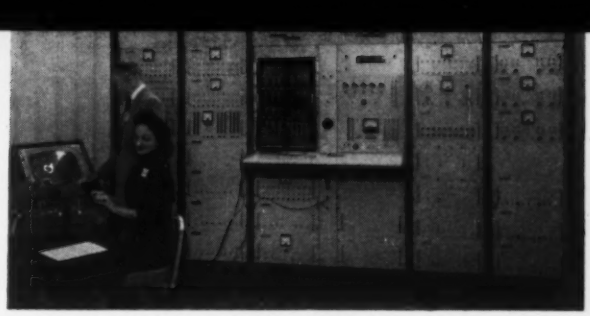
The big analog computer news at the TIAE was digital input and output and automatic computer setup techniques. The Berkeley "1100", introduced at the Automation Show, can do everything but the patching automatically from a remote panel. Electronic Associates also featured digital pot setting from tape recorded data.

As in previous years, the Automation Exposition featured an unparalleled array of data handling and computing equipments. Mention should be made of the Shepard "Servo Transport" digital tape transport in which the tape speed can be servoed to the data density; the Soroban paper tape puncher that can punch 240 code groups per second (see illustration); the Stromberg-Carlson "EUCLID"—Electronic Unitized Components for the Logical Interpretation of Data, which are unitized printed circuits that can be assembled into a variety of special-purpose data-processing devices.

Other Fields

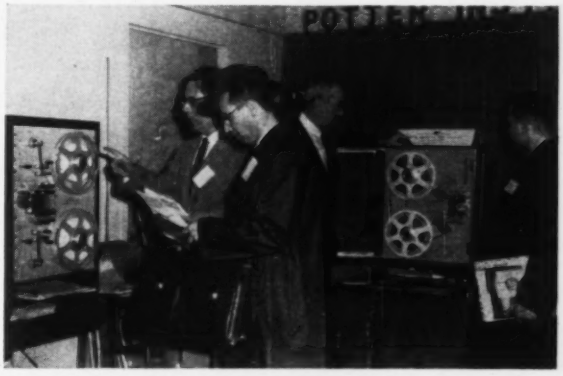
Also as in previous years, the Automation Exposition provided good coverage of the fields of materials handling and warehousing, automatic assembly and fabrication, automatic handling and cleaning of precision components. All these fields are well covered in the *AUTOMATION HANDBOOK*, a technical description of all exhibited products at the TIAE.

A popular exhibit was the "Gambit" (Game For Automation Minded Bigwigs Insensitive to Treachery) of Bendix Computer Div., in which a gorgeous computer operator (female) pitted her wits (and G-15) against



New 1100 Series Analog Computer of Berkeley Div., Beckman, featuring digital input-output systems and automatic set-up, was unveiled at the TIAE—and hundreds of engineers received clinic classes on its principles and operation.

Potter Instrument exhibited magnetic and paper tape handlers—and lectured on its exciting new RAM and Magnistor circuitry.



High flexibility of Gorrell & Gorrell recorders attracted much attention.

Brooks exhibited and lectured on flow measurement with rotameters.

These engineers are watching automatic packaging machinery at work.

Bristol unveiled a fail-safe remote power-positioning system, and also held clinic classes on the many applications of "Dyna-master" potentiometers.

Standard Electronic Research unveiled the world's most stable frequency standard. Cost: $1 per megacycle.

all comers. Your editor came away the winner of a 1-foot stack of chips (coasters are more practical than cash anyway).

Disclosures

Standard Electronic Research made a most important disclosure at the TIAE—an industrial model of the MASER (Microwave Amplification by Stimulated Emission of Radiation) frequency standard. The ammonia molecule emits radiation of a frequency of 23,870,131.12 . . . kc/sec and incomparable stability is derived from the invariant properties of the molecule. Hence the MASER unit boasts a short-time stability of 1 part in 10^{11}, and long-time stability of 1 part in 10^{10}. This exceeds any stability claimed anywhere, to date. It compares with the short-time earth's rotation stability of 1 part in 10^{8}, crystal oscillator stability of 1 part in 10^{9}, and the recently announced Atomichron stability of 1 part in 10^{10}. Also unique is the price: $23,870.13—$1/Mc. (No, you can't buy a few megacycles.)

Many other first disclosures also deserve mention in this report on the Third Automation Exposition. These include:

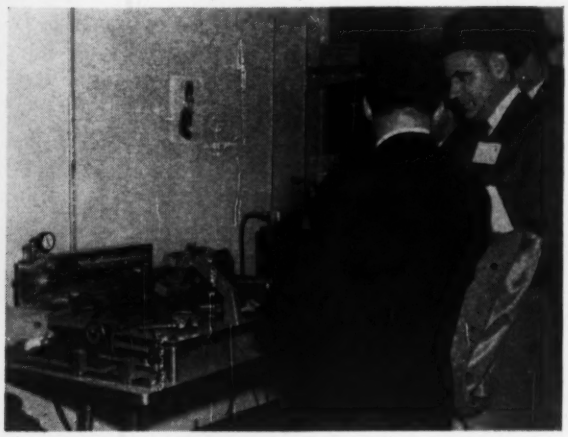
► The new Ease 1100 Series analog computer was disclosed, featuring DO/IT digital output and input translator elements. This system provides automatic set-up of coefficient potentiometers and diode function generators, preprograms the entire problem on punched tape, eliminates much checking and readout, provides digital readout of all amplifiers and other units.

► The Quarie Optimal Controller was unveiled to a startled public for the first time.

► A fail-safe remote power positioning system was introduced by The Bristol Company, who gave an excellent clinic class session on the myriad uses of Dyna-master potentiometers.

► A 16-bit coded disc of W. & L. E. Gurley that is only 5″ in diameter (here the outer scale approaches a

W. & L. E. Gurley unveiled a 5" coded disc with 16 bits, and a reading system that enables a machine-tool operator to set angles within 1 second (equivalent to an angle subtended by 1 inch at 1 mile!).



Automatic Lead Formers, Lead Benders, Lead Straighteners, and other component preparation machines were exhibited by Design Tool Corp.

Axler Associates unveiled an analytical instrument working on the principle of selective absorption of ultraviolet, visible, or near-infrared radiation (0.220-2.7 microns).

Jerrold Electronics exhibited equipment (and lectured) on remote control via integrated ITV systems, and showed how high-definition TV transportation systems can be used in many different ways.

diffraction grating, and the limitation is in reading technique. (An equivalent 18-zone unit would have to be 20″ in diameter!)

► A position-reading system accurate to 1 second was also introduced by W. & L. E. Gurley. (This resolution is equivalent to the angle subtended by 1″ at 1 mile!)

► The NUMILL numerical control system for 2-dimensional profile milling was disclosed by Autonetics Div. of North American Aviation. This machine tool control system uses tape recorded data and is designed to make economic the production of small run quantities, even a single part.

► New line of "MICROtrol" units was disclosed by Airborne Instruments Laboratory, including gaging heads and dimensional indicators.

► Automatic Temperature Control disclosed simple new electric power input controllers that control KWH power input by interrupting the electrical circuit at regular, adjustable intervals.

► Axler Associates (the only manufacturer of ultraviolet transmission filters in the *world*) unveiled a double-beam process stream analyzer operating in the ultraviolet, visible, and near infrared (0.220 to 2.7 microns). Features: simplicity and low cost.

► Beckman Instruments unveiled the "112" Data Processing System featuring computing and data logging tailored to process needs. Heart is the new CADC (Computing Analog-to-Digital Converter) which receives inputs from hundreds of channels, sorts, stores, and computes as required.

► Still another popular spot at the TIAE was the Aard exhibit of materials handling equipment—with the materials being handled by lovely models. (This is automation!?)

► Dage unveiled "dial-selective" closed-circuit TV in which hundreds of remote cameras, monitors and relays can be controlled by a dial-operated system.

► Automatic "SIZE-O-TRON" mechanisms for through feed centerless grinders were unveiled by Kaydon Engineering Corporation.

► It seems appropriate to conclude this Automation Show report with mention of a device that typifies the evolutionary rather than the revolutionary nature of our field. Although most of the data processors and computers at the Automation Exposition used binary and other modern "shorthand" approaches to automation problems, special attention is called to the Telautograph electronic "longhand" units that permit the handwritten message to be transcribed at a remote point. This also is automation.

Other machine-tool control systems were exhibited by Kaydon Engineering and Autonetics (both seen at left) and Airborne Instruments Lab (right).

Reflections of a Visitor to the TIAE

I know you must have received many, many congratulations for the excellent work you did in making the Third International Automation Exposition the huge success that it was. May I add my hearty feelings of approval too, and in addition I would like to give you a few thoughts that passed through my mind at various times during the week.

My particular interest in Automation at present is in the field of automatic test data logging and computation, and I managed to plan my clinic classes so that I sampled fields of analog and digital computers and methods of graphical plotting techniques and analysis in all of six clinics. I confess that this was my first formal introduction to the computing field beyond the ordinary slide rule and desk calculating machine, and I must admit that attending the special classes at the Exposition is surely the easiest and most painless way for the ordinary engineer, long out of school, to start the learning process in the field of automation of his choice. I found, too, that by and large, most of the clinics treated fundamentals, and while "commercials" were offered now and then, these certainly were not objectionable. I came away with a distinct feeling of mental well-being, and pleased to know that my time had been well spent.

Yet, in spite of the well-organized exhibits and well-delivered lectures which were presented by competent engineers and scientists of the automation field, I have been pondering the computing field, in particular, with mixed feelings.

We at our plant were discussing, only the other day, how the use of data logging and computing machines in our engineering department may be a mixed blessing. One person mentioned that, at a company where he used to work, engineers became so used to the availability of high-speed computing machines for performing elementary test engineering analyses that he felt that he and many other test engineers might, at times, be just a little out of touch with the raw or semi-processed test data. Heavy reliance on the logger/computer tends to displace the engineer far from the basic problem; he might someday wake up to find that his powers of technical judgment were becoming masked by the very equipments installed to assist him in his day-to-day work!

A good parallel is the reliance that most engineers now place on the use of slide rules and desk calculating machines. Who nowadays takes a square root by the long-hand method? Who even divides one number by another manually when there is a slide rule around?

It is a chilling thought that the slide rule may some day be as out-of-date as the abacus! It is not hard to conceive of a future elementary and secondary school education in which all children will be taught to use the slide rule, the adding machine, and the desk calculating machine without ever being taught the elementary operations! To see how this might come about one has only to realize how, *even now*, elementary grammar and reading are frequently taught young children before they are required to learn the alphabet! Further, there is also a present tendency to so de-emphasize mathematics in the elementary and high schools, and to so waterdown the disciplinary operations of arithmetic that the very thinking processes of the youths affected are undoubtedly dwarfed.

Engineers must somehow train themselves to be ever more skeptical; they must fight the tendency to depend so much on the machine that their judgment becomes clouded. If their automatic computer turns out an answer or a curve sheet that they do not believe, they must be able, probably by basic long-hand methods, to perform an independent check that will set the problem on the right track. If time permits, it might be intellectually healthy to perform *manually* a Least Squares Analysis on a set of test points, or a Fourier Analysis on a set of harmonic vibration data; or even to solve manually a set of differential equations. It might be surprising, thereby, how the cobwebs of confusion might suddenly be dissolved away!

I want to thank you again for helping to introduce me to the computer and data logger field so dramatically. I enjoyed it thoroughly; and am looking forward to similar Expositions in the future!

Clifford B. Haughton Jr.
Montgomery, Penna.

Dear D.R.*:

Hope you had a nice Xmas and New Year's holiday—and that you are fully recovered, particularly because there are some meaty articles in your issue this month that require just a little bit extra study.

For example, there is more than meets the eye immediately in Dale Kelly's "Short Methods for Calculating Fluid Flow." Dale has listed a number of flow factors for water and air that will give flow when multiplied by the square root of the pressure differential. But—the correction factors and limitations vividly illustrate the other considerations that always enter into a flow calculation. Hence you will learn (or refresh yourself) about many fundamentals of flow calculation by inferential means if you study the correction factors carefully.

We start the new year by finishing up Chet Beard's series on Control Valves with a discussion of "Controller or Regulator?" This leads logically to consideration of regulators—and we are preparing a series for you on this subject. It will be ready in about 2 months.

The "Two-Terminal Relay" material in the Digital Automation Series is also more important than appears on the surface. You will find in future discussions in this series that such relay systems become basic computing and logic elements. Hence a true appreciation of two-terminal relay considerations is required for a lot of material coming your way in the future.

Hope this finds you well and happy.

Cordially,
Milt and The Editors

---

* *Dear Reader*

A NATURAL TIE-IN

for equipment manufacturers

MILITARY AUTOMATION MAGAZINE ⇄ **FIRST MILITARY AUTOMATION EXPOSITION**

MILITARY AUTOMATION magazine—to make its debut in February 1957—will preview the

FIRST MILITARY AUTOMATION EXPOSITION

to be held March 18 to 21, 1957 at the New York Trade Show Building, 500 8th Avenue.

ADVERTISERS who plan to use space in **Military Automation** are urged to consider the advantages of exhibiting in a Show devoted strictly to electronics, and control equipment and components, as applied by and for the military. (IRE's annual show will be at the Coliseum the same four days. Buses will shuttle engineers between the two shows.) Richard Rimbach Associates, who managed the recent and highly successful Third International Automation Exposition, will also manage the First Military Automation Exposition.

EXHIBITORS who plan to display their MIL-spec equipment at the First Military Automation Exposition should also consider the unique advertising values available through the pages of **Military Automation** magazine. "King-size" properly describes M-A . . . its format, its audience, and its editorial staff.

Reserve your exhibit space for the
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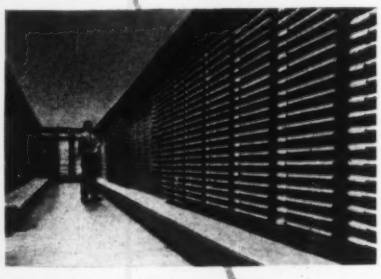

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Two-Terminal Relay Circuits

Many basic logical circuits can be developed from two-terminal relays. The required logic usually leads to the use of many relays, many of which can be proved to be redundant and useless by the use of simple binary techniques. Startling simplifications often can be effected.

MARTIN L. KLEIN
FRANK K. WILLIAMS
HARRY C. MORGAN
Rocketdyne Div.,
North American Aviation, Inc.

DIGITAL techniques can be used in the design of relay and electromechanical switching circuits. Although such design is conveniently handled with Boolean algebra, considerable insight into switching circuits can be obtained using the concepts of binary numbers developed previously.

A two-terminal relay circuit can be considered one which either makes or breaks the circuit according to certain specified conditions. Fig. 15-1 shows a black box with a single input and output. This two-terminal device can have some arbitrarily specified conditions for closure and nonclosure.

In designing switching circuits to comply with input requirements, meaningless switches often are left in the circuit, as shown in Fig. 15-2. Here switch B is absolutely meaningless and has no effect on the circuit because when switch A is open, B can never close the circuit —and when switch A is closed, B can never open it. In other words, switch B is redundant and is wasted in this relay circuit. It is not often the case that redundant switches are found so simply.

Let us investigate the general case of single-pole double-throw switches. The switch can be either normally open or normally closed; the latter will be designated by prime signs—that is, switch A′ is normally closed; switch A is normally open. Switch A′ (normally closed) needs to be energized to open it, whereas switch A (normally open) needs to be energized to close it.

Switches in series will be represented by a plus sign so that the switch circuit of Fig. 15-3 can be described as

$$A' + B + C'$$

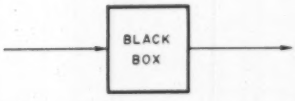


Fig. 15-1. Black-box representation of a 1-input 1-output device, which may have any arbitrarily specified condition for closure or nonclosure of the circuit.

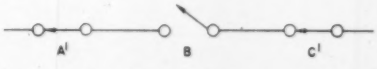


Fig. 15-3. A' plus B plus C' means a normally open switch (B) in series with two normally closed switches (A' and C').

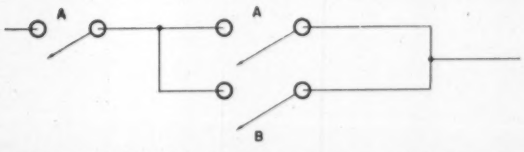


Fig. 15-2. Example of a meaningless switch (B), which often is designed into digital equipments. When A is open, B can never close the circuit, and when A is closed, B can never open it.

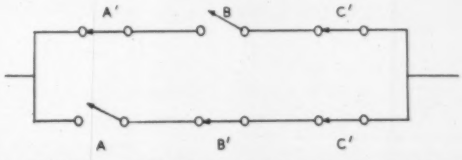


Fig. 15-4. Parallel switch circuits showing normal unenergized states. Circuit can be represented as (A'+B+C')(A+B'+C').

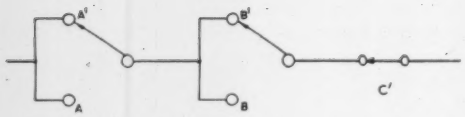


Fig. 15-5. The parallel switch circuit of Fig. 15-4 can be simplified to two single-pole double-throw switches and one single-throw switch.

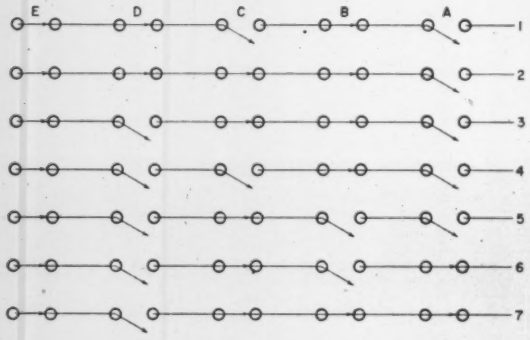


Fig. 15-6. General case of parallel switching logic, using a 7-path circuit.

Let us assume that all switches are solenoid operated, and let us follow conventional binary technique by calling 0 the absence of a signal and 1 the presence of a signal.

Referring to Fig. 15-3, the binary signal needed to close the circuit is 010—that is, switch B must be changed (energized) and the others left in normal condition (0). As there are eight possibilities with three bits, any binary number (signal) from 000 to 111 other than 010 means an open circuit.

Let us place another set of switches in parallel with the three above, as in Fig. 15-4. Here the A switches are mechanically linked, as are the B and C switches. It is obvious, since the switches are in parallel, that there are two possible paths for closure—that is, an A signal would close the lower circuit, or a B signal would close the upper circuit. This suggests that switches in parallel multiply the parallel branch conditions for closure. The composite circuit can be represented as:

$$(A' + B + C')\ (A + B' + C').$$

Here either an 010 or 001 signal would result in circuit closure. (Note that the "A" signal is the rightmost or least significant bit.)

This circuit can be represented in binary code as:

(010) (001)

Of the eight possible switch positions, six give non-closure—000, 100, 011, 101, 110, and 111: only 010 and 001 give closure. However, it can be seen that the A and B switch are not needed because no matter which position each is in, the circuit is closed.

This can be seen by listing the closure conditions (010) (001) in tabular form as follows:

C	B	A
0	1	0
0	0	1

and noting that closure occurs whether A is open or closed or whether B is open or closed. Hence A and B are redundant.

Fig. 15-5 shows how the parallel switch circuit of Fig. 15-4 can be simplified to two single-pole double-throw switches and one single-throw switch in series. Obviously, switches A and B are useless.

Finding Redundant Switches in a 4-path system

Let us expand this idea by using four parallel relay paths, each containing three relays. There would now be four sets of conditions which cause circuit closure, and these might be represented by:

$$(A' + B' + C')\ (A' + B + C')\ \mathbf{x}$$
$$(A' + B' + C)\ (A' + B + C)$$

In binary number notation, the conditions (required signals) for closure are:

(000) (010) (100) (110).

Again, there are eight (2^3) possible relay combinations because the four A switches are ganged, as are the B and C switches.

Let us list the closure conditions in tabular form:

C	B	A
0	0	0
0	1	0
1	0	0
1	1	0

On examining this tabulation, we not that the A relay does not change in value, remaining a 0 for all closure conditions. However, the B and C relays pass through all four possible combinations of 2 relays (2^2 combinations).

It is apparent, then, that the conditions for closure include all possible combinations of conditions of these two latter relays; hence they are redundant. The circuit will always be closed, independent of the state of B and C. The circuit will operate equally well without them and, therefore, the above circuit depends exclusively for its operation on the state of A. The whole relay circuit is thus expressed simply by A', the other relays serving no purpose whatever.

Simplifying a 7-Path Circuit

To carry this to a more general case, consider the following tabulation of seven conditions for circuit closure, as in Fig. 15-6. Here again, the A switches are ganged, as are the B, C, D, and E switches. There are 2^5 or 32 possible circuit conditions, but only the following seven conditions or signals will give closure:

	E	D	C	B	A
line 1	0	0	1	0	1
line 2	0	0	0	0	1
line 3	0	1	0	0	1
line 4	0	1	1	0	1
line 5	0	1	0	1	1
line 6	0	1	0	1	0
line 7	0	1	0	0	0

Using binary technique, let us simplify this circuit and eliminate any redundant or meaningless relays in the circuit. First, consider lines 1, 2, 3, and 4. We see that relays A, B, and E are unchanged, but that relays C and

D pass through every possible (2^2) combination for the two relays. Thus relays C and D are not essential for closure, and the first four circuits can be described effectively as one normally open switch in series with two normally closed relays—that is,

$$A + B' + E'.$$

Let us now consider lines 5, 6, and 7, which we can look at in conjunction with line 3 to give the following table of closure conditions:

	E	D	C	B	A
line 3	0	1	0	0	1
line 5	0	1	0	1	1
line 6	0	1	0	1	0
line 7	0	1	0	0	0

We see here that by considering line 3 along with 5, 6 and 7, we have fixed values for E, D, and C, but relays A and B go through all possible combinations. Therefore, these 4 paths can be replaced by one path consisting of one normally open relay in series with two normally closed relays—that is,

$$C' + D + E'.$$

The two possible closure conditions (omitting the redundant relays which cause closure no matter what their condition) give the equivalent relay circuit operation as:

$$(A + B' + E')\ (C' + D + E')$$

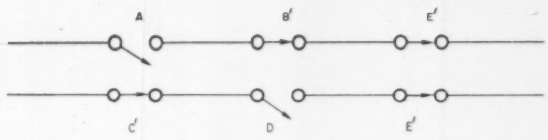


Fig. 15-7. Simplified switching logic equivalent to that of Fig. 15-6.

and this circuit (Fig. 15-7) is entirely similar in its operation to that of Fig. 15-6. Using the binary arithmetic technique of finding relays which appear in all possible combinations while the balance of the relays remain unchanged allows simplification of many multiple-condition relay circuits. All lines (rows) can be considered as many times as needed, but each line must be considered at least once. This is fruitful in applications where the same relay closes under various conditions, as in the above case where the five relays created closure in different combinations. Obviously, where every relay is different and closes under different conditions—such as in the parallel circuits (A+B+C) (D+E+F)—no simplification is possible. It is only where the same relay appears in parallel branches that we can hope to find redundant relays which can be eliminated.

Valve Pressure-Drop Nomograph

D. S. DAVIS, Professor of Engineering, University of Alabama

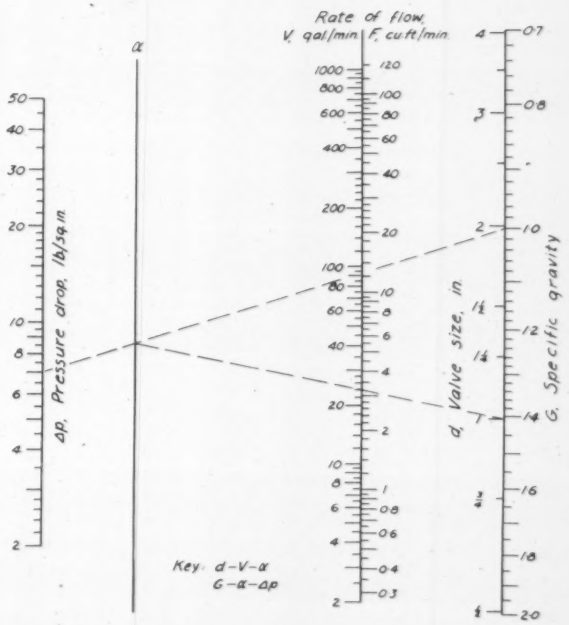
USE THIS nomograph to predict pressure drop, for liquids, across parabolic plug valves.

For valves handling liquids, the equation—

$$d^2 = (V/9)\,(\sqrt{G/\Delta p})$$

—where d is valve size in inches, V is rate of liquid flow in gal/min, G is specific gravity of liquid, and Δp is pressure drop in psi—enables one to predict pressure drops around parabolic plug valves.* This equation also can be solved readily and accurately by means of the accompanying nomograph, which was constructed in accordance with well-known methods[2].

For example: What pressure drop should be expected around a 1-inch control valve when a liquid with a specific gravity of 1.0 flows at the rate of 24 gal/min? Follow the key; connect 1 on the d scale and 24 on the V scale with a straight line, and mark its intersection with the α axis. Connect this α intersection point and 1.0 on the G scale with a straight line and mark its intersection with the p scale. In this case, 7.0 is the expected pressure drop in pounds per square inch.



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1. Rhodes, T. J., *Industrial Instrumentation for Measurement and Control*, McGraw-Hill Book Co., Inc., 1941.
2. Davis, D. S., *Nomography and Empirical Equations*, Chap. 6, Reinhold Publishing Corporation, 1955.

* Author used Brown Instrument Co. parabolic plug valve in constructing this nomograph.

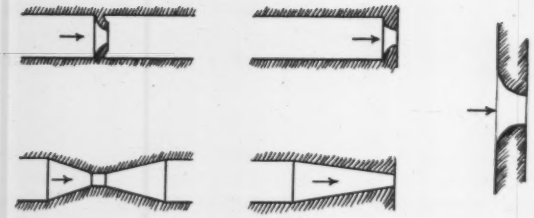


Fig. 1. Various shapes of venturis and nozzles.

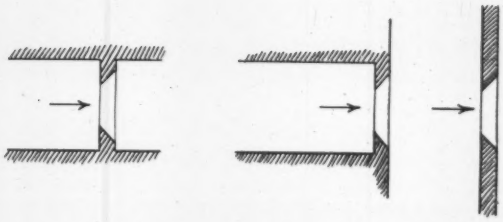


Fig. 2. Sharp-edged orifices.

Short Methods for

Here is a short-cut method for calculating flow within 1% accuracy for conventional flow elements. The coefficients in the tables are derived from the formulae at the end of this article.

DALE KELLY
Consulting Engineer

CALCULATION, by conventional methods, of fluid flow from the pressure differential developed by a venturi, nozzle, sharp-edged orifice, or pitot tube is only a little less formidable than the preparation of an income tax return. Here are some quicker ways:

For Water

Select the most suitable flow factor from Table 1 and multiply it by the square root of the pressure differential. This gives the discharge per circular inch. For total flow, multiply by the square of the throat diameter (in inches) of the venturi, nozzle, or orifice. (Of course, this does not apply to determination of outlet velocity of a pitot, which data are given at the bottom of the table.)

For Air

The venturi, nozzle, or orifice preferably should be either (1) large enough that the pressure differential is only a few percent of the absolute upstream pressure (gage pressure plus 14.7 psia), or (2) so small that the absolute downstream pressure is less than half of the absolute upstream pressure.

For Case (1): Select the most suitable flow factor from Table 2 and multiply it by the square root of the pressure differential. This gives the discharge per circular inch. For total flow multiply by the square of the throat diameter (in inches) of the venturi, nozzle or orifice.

For Case (2): Select the most suitable flow factor from Table 3. Multiply by the square of the diameter (in inches) of the venturi or nozzle, and by the absolute upstream pressure (*not* the square root of the pressure) and divide by 100. The sharp-edged orifice should not be used for high pressure-differentials. (Note that steam flow may also be calculated if the appropriate flow factors are used.)

The unit of cross-sectional area used in all of the tables is the circular inch, or area of a circle one inch in diameter. Thus the area of a circle of 2″ dia is 4 circular inches, that of a 3″ circle is 9 circular inches, etc.

Limitations of Short Method

In nearly all cases this short method will give a good approximation to the actual flow; in many cases it will give just as accurate a value as the longer, conventional calculation. Where very high accuracy is required, or unusual conditions exist, calculations should be based on the longer and more exact conventional formulae. The limitations of the short method are as follows:

Correction Factors For Table 1

Table 1 *is correct only under the following conditions*:

(1) Density of the water is 62.36 lb/cu ft. This value is within 1% at any temperature up to 120°F and within 5% up to 230°F.

(2) The coefficient of discharge (ratio of actual flow to theoretical flow) is 0.99 for the venturi and nozzle, 0.61 for the sharp-edged orifice, and 1.02 for the pitot tube. The coefficient of discharge is between 0.98 and 1.00 for a venturi or nozzle, and between 0.61 and 0.63 for sharp-edged orifice, provided that (a) the throat is an inch or more in dia, (b) the pressure differential is 0.4 psi (corresponding to a head of one foot of water) or more, and (c) the pipe (if any) leading to the venturi, nozzle, or orifice has a diameter at least twice the throat diameter. The coefficient of discharge of a good pitot tube is usually between 1.01 and 1.03. For these conditions the values given in the table usually will be cor-

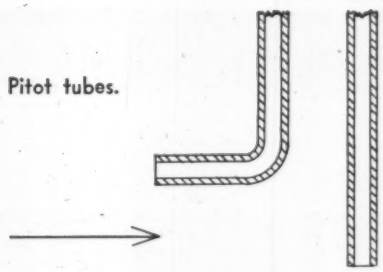


Fig. 3. Pitot tubes.

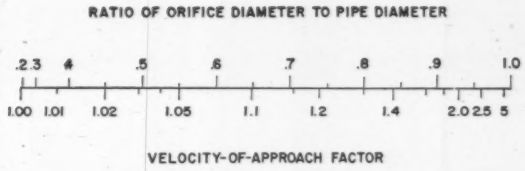


Fig. 4. Velocity-of-approach factor for various ratios of orifice diameter to pipe diameter.

CALCULATING FLUID FLOW

rect within 1%, but always within 2%. If some of the conditions above do not prevail, or greater accuracy is required, multiply the values in the table by the coefficient of discharge for the particular conditions, as determined from the literature or by test, and divide by 0.99 for the venturi or nozzle, by 0.61 for the sharp-edged orifice, or by 1.02 for the pitot tube.

(3) The throat of the venturi, nozzle or orifice is so much smaller than the pipe (if any) leading up to it that the kinetic energy of the approaching fluid is negligible. The error thus introduced will be less than 4% if the throat diameter is one half of the pipe diameter, or less, and 1/5 of 1% if the throat diameter is ¼ of the pipe diameter. Where greater accuracy than this is required, multiply by the velocity-of-approach factor from Fig 4.

Liquids Other Than Water

If the flow factors in Table 1 are to be used for liquids other than water they must be modified as follows.
Values marked (A) should be multiplied by $1/\sqrt{\sigma}$
Values marked (B) need no modification, but head must be in feet or inches of the fluid being measured.

Table 1.—Flow Factors for Water

Pressure differential or head →		1 psi	1 inch of water (1" WC)	1 foot of water (1' WC)	1 inch of water (1" WC) over mercury (Hg)*
Discharge per circular inch	Venturis and nozzles	(A) 0.06585 cfs 3.951 cfm 237.1 cfh 0.4926 gps 29.56 gpm 1773.0 gph	(B) 0.01250 cfs 0.7502 cfm 45.01 cfh 0.09354 gps 5.612 gpm 336.7 gph	(B) 0.04332 cfs 2.599 cfm 155.9 cfh 0.3240 gps 19.44 gpm 1166.0 gph	(C) 0.04437 cfs 2.662 cfm 159.7 cfh 0.3318 gps 19.91 gpm 1195.0 gph
		(D) 4.103 lb/sec 246.2 lb/min 14770.0 lb/hr	(E) 0.7790 lb/sec 46.74 lb/min 2804.0 lb/hr	(E) 2.699 lb/sec 161.9 lb/min 9715.0 lb/hr	(E) 2.764 lb/sec 165.8 lb/min 9951.0 lb/hr
	Sharp-edged orifice plates	(A) 0.04058 cfs 2.434 cfm 146.1 cfh 0.3035 gps 18.21 gpm 1093.0 gph	(B) 0.007704 cfs 0.4623 cfm 27.74 cfh 0.05763 gps 3.458 gpm 207.5 gph	(B) 0.02669 cfs 1.601 cfm 96.08 cfh 0.1996 gps 11.98 gpm 718.7 gph	(C) 0.02734 cfs 1.640 cfm 98.42 cfh 0.2045 gps 12.27 gpm 736.2 gph
		(D) 2.528 lb/sec 151.7 lb/min 9100.0 lb/hr	(E) 0.4800 lb/sec 28.80 lb/min 1728.0 lb/hr	(E) 1.663 lb/sec 99.76 lb/min 5986.0 lb/hr	(E) 1.703 lb/sec 102.2 lb/min 6131.0 lb/hr
Outlet velocity of pitot tube		(A) 12.44 fps 746.4 fpm 8.482 mph 7.366 knots	(B) 2.362 fps 141.7 fpm 1.610 mph 1.399 knots	(B) 8.182 fps 490.9 fpm 5.579 mph 4.845 knots	(C) 8.381 fps 502.9 fpm 5.714 mph 4.962 knots

*Difference between mercury levels in the two legs of a U-tube manometer having mercury in the lower part and water above the mercury in both legs.

Table 2.—Flow Factors for Air at Low Pressure-Differentials

Pressure differential →		1 psi	1 inch of water (1"WC)
Discharge per circular inch	Venturis and nozzles	(G) 1.884 scfs 113.0 scfm 6782.0 scfh	(G) 0.3577 scfs 21.46 scfm 1288.0 scfh
		(H) 0.1434 lb/sec 8.605 lb/min 516.3 lb/hr	(H) 0.02723 lb/sec 1.634 lb/min 98.03 lb/hr
	Sharp-edged orifice plates	(G) 1.142 scfs 68.51 scfm 4110.0 scfh	(G) 0.2168 scfs 13.01 scfm 780.5 scfh
		(H) 0.08692 lb/sec 5.215 lb/min 312.9 lb/hr	(H) 0.01650 lb/sec 0.9902 lb/min 59.41 lb/hr
Outlet velocity of pitot tube		(G) 355.9 fps 21,350.0 fpm 242.6 mph 210.7 knots	(G) 67.57 fps 4054.0 fpm 46.07 mph 40.01 knots

Values marked (C) should be multiplied by $\frac{\sqrt{13.59-\sigma}}{12.59\sigma}$ and head must be measured with mercury and the fluid being measured.

Values marked (D) should be multiplied by $\sqrt{\sigma}$

Values marked (E) should be multiplied by σ

Values marked (F) should be multiplied by $\sqrt{\sigma(13.59-\sigma)}/12.59$ and the head must be measured with mercury and the fluid being measured, where σ=Specific Gravity.

Correction Factors For Table 2

Table 2 is correct only:

(1) When the air is at standard condition (pressure of 29.92"Hg and temperature of 60°F). An error of 1% will result from a temperature change of 10% or a pressure change of 0.6"Hg. If this error cannot be tolerated, *divide* values marked (G) by

$$\sqrt{\left(\frac{P}{29.92}\right)\left(\frac{520}{460+T}\right)}$$

and *multiply* values marked (H) by the same factor. (P is pressure in inches Hg and T is temperature in °F.) Fig. 5 gives this correction factor, without calculation, for the most common pressures and temperatures.

(2) If the coefficient of discharge (ratio of actual flow to theoretical flow) is 0.99 for the venturi or nozzle, 0.60 for the sharp-edged orifice, and 1.02 for the pitot tube.

The coefficient of discharge of a venturi or nozzle is between 0.98 and 1.00 as long as: (a) the diameter of the venturi or nozzle is not over half that of the pipe (if any) leading up to it, and (b) the pressure differential is over 0.2 psi (5"WC) for a throat diameter of 2" or 0.015 psi (0.4" WC) for a throat diameter of 8".

The coefficient of discharge of a sharp-edged orifice of 1" dia or more is between 0.59 and 0.61 as long as: (a) the pressure taps are located not more than one pipe dia upstream or downstream from the orifice, and (b) the pressure differential is not over 6% of the upstream pressure for an orifice whose diameter is 30% or less of the pipe diameter, or 3% of the upstream pressure for an orifice whose diameter is 50% or less of the pipe diameter.

Table 3.—Flow Factors for High Pressure-Differentials

(Discharge per circular inch for an upstream pressure of 100 psia)

For use only when the downstream pressure is less than half of the upstream pressure.

	AIR	STEAM
Venturis and nozzles	23.35 scfs 1401.0 scfm 84,050.0 scfh	
	1.777 lb/sec 106.6 lb/min 6398.0 lb/hr	1.088 lb/sec 65.30 lb/min 3918.0 lb/hr

The coefficient of discharge of a good pitot tube is usually between 1.01 and 1.03.

(3) When the throat of the venturi, nozzle or orifice is so much smaller than the pipe (if any) leading up to it that the kinetic energy of the approaching fluid is negligible. The error thus introduced will be less than 4% if the throat diameter is one half of the pipe diameter, or less, and 1/5 of 1% if the throat diameter is 1/4 of the pipe diameter. Where greater accuracy than this is required multiply by the velocity-of-approach factor from Fig. 4.

(4) For small pressure differentials: For all the common gases, multiplication of the values in the table by one of the two factors (f) below will correct within 0.5% for any pressure differential up to 1/10 of the upstream pressure (within 1/10% for any differential up to 2%), except in the case of a venturi, nozzle, or orifice installed in a pipe whose diameter is less than twice the throat diameter.

For a venturi, nozzle or sharp-edged orifice

$$f=1-0.6(\Delta P/P)$$

For a pitot tube

$$f=1-0.2(\Delta P/P)$$

P and Δ P are the absolute upstream pressure and the pressure differential, respectively, expressed in the same units.

Gases Other Than Air

If the flow factors in Table 2 are to be used for gases other than air they must be modified as follows:

Values marked (G) must be multiplied by $1/\sqrt{\sigma}$

Values marked (H) must be multiplied by $\sqrt{\sigma}$

Note: Specific Gravity (σ) is referred to air.

Correction Factors For Table 3

In Table 3: (1) The values given for air are for measurements at a temperature of 60°F, but they will be correct within 5% at any temperature between 10 and 110°F. For better accuracy multiply the values in the table by $\sqrt{520/(460+T)}$. To convert the values given for volume of air to volume at other conditions than 29.92"Hg and 60°F, multiply by

$$\left(\frac{29.92}{P}\right)\left(\frac{460+T}{520}\right)$$

(2) The values given for steam apply most accurately to saturated steam with a low moisture content. They should not be used when moisture content or superheat is high.

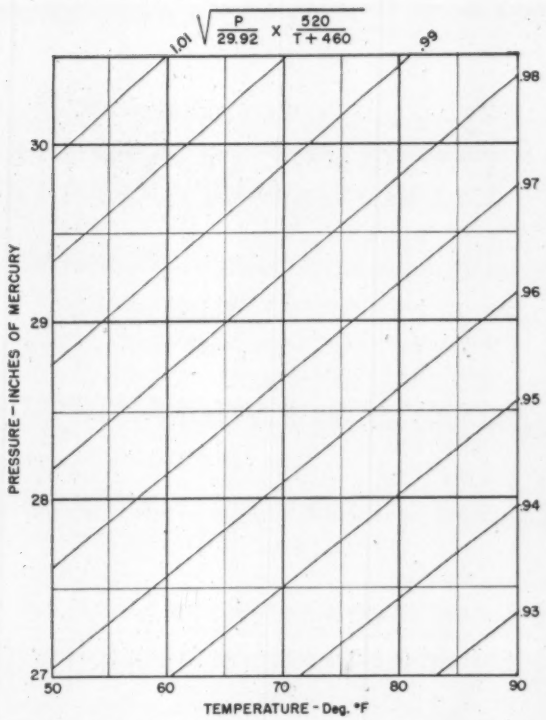


Fig. 5. Correction factor for non-standard conditions.

(3) The table is correct only when the nozzle diameter is small and the coefficient of discharge (ratio of actual flow to theoretical flow) is 0.97. The tabulated values should be correct within a few percent as long as the diameter of the nozzle is less than ½ that of the pipe (if any) leading up to it.

Gases Other Than Air

To obtain flow factors correct within 5% for gases other than air, modify the factors given for air in Table 3 as follows:

For volume (cubic feet) multiply by $\sqrt{29/M}$

For mass (pounds) multiply by $\sqrt{M/29}$ where M= Molecular Weight.

APPENDIX

Derivation of Table 1

The standard formula for total flow (Q) in time t, as applied to differential-type meters, is:

$$Q = CAt\sqrt{2gH}$$

In order to convert this formula into a formula useful with different units, we can state that the total volume Q=NV, where N is the number of volumetric units and V is the volume of each unit. Hence the basic formula becomes:

$N = (1/V)(C)(A)(\sqrt{2gH})(t)$ where

N = number of units
V = volume of each unit (cubic feet)
C = coefficient of discharge
A = area of opening (square feet)
g = 32.174 ft/sec/sec (acceleration of gravity)
H = head across the meter (in feet of fluid being measured)
t = time (seconds)

All the quantities in Table 1 are evaluations of the above formula for

V = 1	for discharge in cubic feet, or velocity in feet per second
V = 231/1728	for discharge in gallons
V = 1/62.36	for discharge in pounds
V = 5280	for velocity in miles per hour
V = 6080	for velocity in knots
C = 0.99	for a venturi or nozzle
C = 0.61	for an orifice plate
C = 1.02	for a pitot tube
A = 1	for velocity
$A = \left(\frac{\pi}{4}\right)\left(\frac{1}{144}\right)$	for discharge per circular inch
H = 1	for one foot of water
H = 1/12	for one inch of water
H = 144/62.36	for one pound per square inch
$H = \frac{(13.59-1)}{12}$	for one inch of water over mercury
t = 1	if flow per second is desired
t = 60	if flow per minute is desired
t = 3600	if flow per hour is desired

Derivation of Table 2

The derivation of Table 2 is the same as that of Table 1 except that

V = 13.136	(cubic feet per pound of air at 29.92″Hg and 60°F) is used for discharge in pounds
C = 0.60	for an orifice plate
H = (144) (13.136)	for one pound per square inch
$H = \left(\frac{(62.3)\ (13.136)}{12}\right)$	for one inch of water

Derivation of Table 3

For a downstream pressure less than half of the upstream pressure, mass flow of air or steam may be expressed as follows

Air

$$W = 0.532\ C(AP/\sqrt{T})(t)$$ (Fliegner's Formula)

Steam

$$W = (1/70)CAPt$$ (Napier's Formula)

where W = weight of fluid (pounds), C = coefficient of discharge, A = area of opening (square inches), P = absolute upstream pressure (pounds per square inch), T = absolute temperature (degrees F), t = time of flow (seconds)

All the quantities in Table 3 are evaluations of the above formula for

C = 0.97 for a nozzle or a venturi,
A = $\pi/4$
P = 100
T = 520
t = 1, 60 or 3600

Velocity of Approach

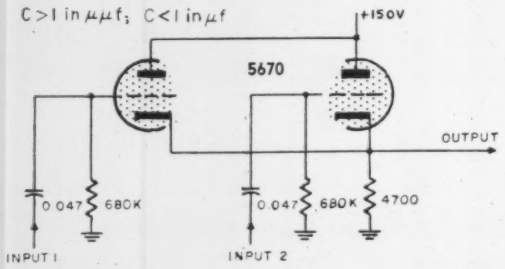
The graph, (Fig. 4) for velocity of approach factor gives values of the conventional factor,

$$1/\sqrt{1-(\text{Orif. Diam.}/\text{Pipe Diam.})^4}$$

COMMON-CATHODE VIDEO MIXER

The term "video mixing" refers to the combining of different pulse signals (such as radar returns and range markers or beacon signals) for simultaneous presentation on one indicator, and should not be confused with intermodulation mixing (heterodyning). The video mixer should be "nonadditive"—that is, the output should not be greater in amplitude than the output when only the larger of the input coincident signals is present, in order to prevent high-amplitude signals that cause "blooming" of the target blip on the cathode-ray indicator. This circuit, NBS preferred circuit PC23, is a common-cathode-type video mixer.

The advantage of common-cathode mixing over common-plate mixing is smaller additive factor (20% for 4-v inputs). This nonadditive feature is obtained as a



result of the cross-biasing at the cathode by coincident positive input signals. The additive factor is defined as:

$$\text{Additive factor} = (E_1 - E_2)\ (100)/E_3$$

where: E_1 is the output for time coincident inputs
E_2 is the output when only the larger input is present
E_3 is the output when only the smaller input is present

Two additional sections can be paralleled to provide 4 inputs, with little change in operating characteristics.

Inputs: Positive pulses, up to 14 v amplitude.

Output: Positive pulses, 11 v with 14 v inputs.

Additive factor: 20% for 4-v inputs.

Rise Time: 0.05 usec with 50-uuf output capacity.

Output Impedance: 500 ohms.

Droop: 2% for 500-usec pulses.

Source: NavAer 16-1-519, *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D. C.

COMMON-PLATE VIDEO MIXER

This circuit, like the common-cathode mixer, is used in radar circuits to combine radar video pulses with other information such as range markers. It is NBS-BuAer Preferred Circuit PC24.

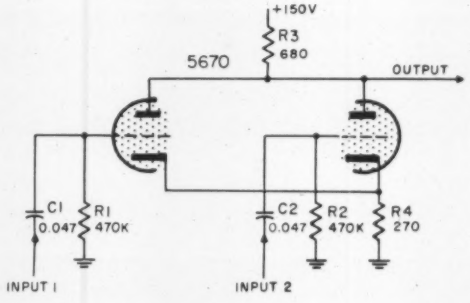
There are two principal differences between the common-plate mixer and the common-cathode type: first, the common plate mixer inverts the phase of the input pulses and delivers a negative output, and second, the additive factor of this circuit is undesirably high (55%). (It is desired that the output for coincident signals be no greater than the output for the larger signal alone, corresponding to an additive factor of zero.) When additive mixing is obtained, the resulting large output could cause overloading in the video chain and "blooming" of the target blip on the cathode-ray indicator. Because of the high additive factor of the common-plate mixer, it should be followed by a limiting stage.

ELECTRONIC

CHARLES F. KEZER
Key Electric Corp.
and
MILTON H. ARONSON
Instruments & Automation

A single Type 5670 miniature dual triode is used. Positive pulse input to either (or both) grids produces a negative output at the common plates. The low value (680 ohms) of plate resistor is used to obtain a rapid rise time of 0.03 usec, at the expense of gain. Gain is approximately unity; this has the advantage of minimizing the Miller effect and thus producing low input capacity.

The unbypassed cathode resistor (270 ohms) stabilizes the circuit against changes in gain with tube aging. Four inputs can be mixed by paralleling two additional tube



sections. Normally, this will reduce the gain to one-half; gain can be brought back to unity by decreasing the cathode resistor to 100 ohms. Rise time of the output signal is equally good with four tube sections.

Inputs: Positive pulses, 3.5-v amplitude.

Output: Negative pulses, 4-v amplitude for either input, 6.2 v when both inputs are present.

Gain: Approximately unity.

Additive factor: 55% at level given above.

Droop: 2% for 500-usec pulse.

Rise time: 0.03 usec with 15-uuf external load capacitance.

Source: NavAer 16-1-519, *Handbook of Preferred Circuits, Navy Aeronautical Electronic Equipment*, National Bureau of Standards, Washington, D. C.

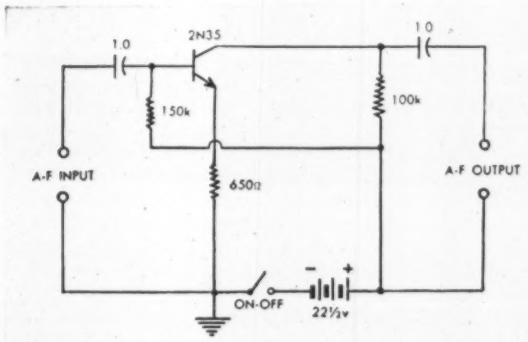
TRANSISTOR PREAMP HAS GAIN OF 100

This common-emitter preamplifier has voltage gain of 100 and frequency response from below 50 to over 10,000

CIRCUITRY

The circuit is the heart of all electronics. Here are 4 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

cps (voltage gain is down only 1 db at 10,000 cps). By short-circuiting the 650-ohm emitter resistor, voltage gain is increased to 370, with slightly improved frequency response. While the degeneration introduced by this resistor (analogous to an un-bypassed cathode resistor) reduces gain, it has the desirable effect of increasing the input resistance by 20 times, to 30,000 ohms. Other desirable effects are reduction of distortion and improved stability, as are obtained by degeneration in vacuum-tube amplifiers.



One application of the circuit is as a preamplifier for a dynamic microphone. The circuit, by using tiny tantalum electrolytic capacitors, can be built small enough to fit into the microphone handle, and will raise the microphone voltage to the level needed to drive available power amplifiers. Another application is a probe preamplifier for an a-c vacuum-tube voltmeter, extending meter ranges down to millivolts.

Circuit may be used also at battery voltages down to 1.5 v dc, by reducing collector and emitter resistor values. At these lower battery voltages, however, voltage gain and maximum undistorted output voltage are drastically reduced. For example, with 1.5-v battery supply, and using collector resistor of 6,500 ohms (without degeneration), voltage gain is only 32 and maximum undistorted output is only 0.16 v rms.

Circuit is intended for operation into a high-impedance load (500K ohms or higher). Voltage gain and frequency response measurements were made with a signal generator of 600-ohm output impedance and a high-impedance a-c VTVM.

Transistor is a Sylvania type 2N35 NPN; the PNP type 2N34 also may be used, but battery polarity must be reversed from that shown when the PNP type is substituted.

Voltage Gain: 100 at 1000 cps.

Frequency Response: Down 0.1 db at 50 cps; 1 db down at 10,000 cps.

Input Impedance: 30,000 ohms at 1000 cps.

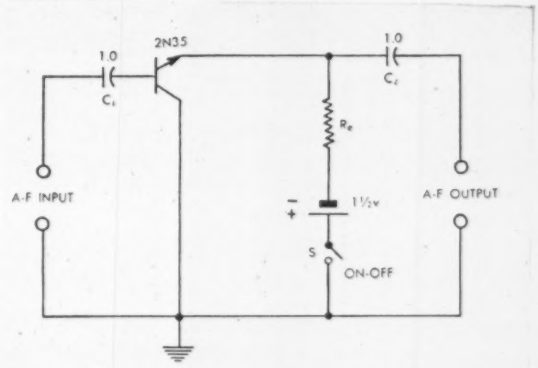
Maximum Undistorted Output: 3.5 v rms.

B Supply: 22.5 v at 100 ua.

Source: Booklet, 28 *Uses for Junction Transistors*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

COMMON-COLLECTOR AMPLIFIER

The common-collector amplifier is analogous to the vacuum-tube cathode follower—that is, it has relatively high input impedance, low output impedance, less-than-unity voltage gain, and does not reverse signal phase.



TABLE—Performance with 1.5-volt supply

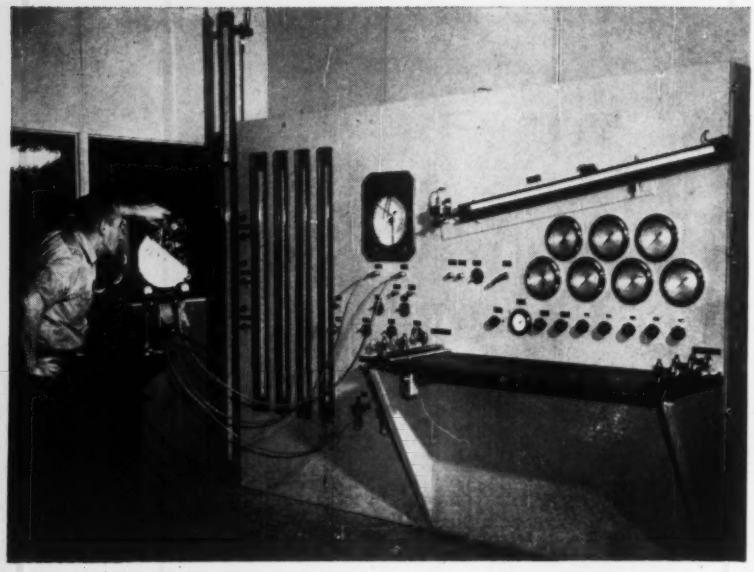
Emitter Resistor, R_e (ohms)	Input Impedance (ohms)	Input Voltage (rms volts)	Maximum Undistorted Output (v rms)	Voltage Gain	Approx. Output Impedance (ohms)	Current Drain (d-c μa)
50,000	100,000	0.40	0.38	0.95	3,000	40
25,000	100,000	0.42	0.40	0.952	2,700	42
10,000	100,000	0.41	0.38	0.928	2,500	90
1,000	40,000	0.10	0.071	0.71	280	120
500	22,000	0.052	0.027	0.52	250	125

The table shows how input impedance, output impedance and voltage gain vary with emitter resistor value. High output impedance is obtained by using a low supply voltage and by the "floating base" arrangement (no fixed d-c base bias).

Frequency response is excellent; full gain is obtained at 50 cps and gain is down only 1 db at 50,000 cps. Gain and frequency response were measured with a signal generator of 600-ohm ouput impedance and a high impedance VTVM.

The 2N35 junction transistor shown is an NPN type; the PNP type 2N34 may be used by reversing polarity of the supply battery.

Source: Booklet, 28 *Uses for Junction Transistors*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.



W. (Bill) McLay calibrates a flow controller-recorder at the pressure-vacuum-flow test panel.

Process⇄

ON page 59 you met Jim Murray of Monsanto's Everett Plant. The folks at this plant are justifiably proud of the instrument shop which the men of the instrument department have developed.

The area of the shop itself is about 1800 square feet. There is also a stock room and salvage room, each measuring about 325 sq. ft. The shop is manned by five second class workers, five first class workers and a foreman (Jim Murray). One of the first class men has a permanent leader rating.

Each man has a bench equipped with a 3-inch swivel vise, one unregulated and two regulated air supplies, illuminating gas, and 110-220-volt single-phase power.

There is one heavy wooden bench similarly equipped for large work, a thermocouple bench, a power-tool bench, a pH repair bench, a paint-spray booth, a drying oven and a general-purpose sink.

Most newsworthy is the pressure-vacuum-flow test panel, comprising five pressure test gages connected through valves to a common manifold, a sloping manometer for low-pressure work, two manometers for absolute pressure and vacuum testing, three manometers for checking pressure and flow instruments, and a pressure recorder for checking the constancy of alignment of pneumatic controllers over a period of time.

All air lines to and from instruments to be calibrated are attached by means of snap-on plug connections. Two dead weight testers are used to check test gages.

Miscellaneous equipment in the shop includes a one-ton portable crane for lifting heavy material, an oxygen-

A. (Angie) Moro calibrates and checks a process controller.

J. (Jack) Henry checks out a pH meter after repairs.

Al De Pietro, Lead Man, trouble-shoots a potentiometer amplifier.

Instrumentation

It's not often that six of the instrument men are in the shop at the same time; the plant has to be running smoothly in order to get this photo.

acetylene welding torch mounted on a mobile hand truck, and small stands mounted on casters for holding instruments.

An electrical test room is now being contructed. This will house a console type test board consisting of several panels to include a precision potentiometer, Ayrton shunt, special cold-junction terminal enclosure and necessary switching; current panel with five calibrated dc circuits; a voltage panel with four calibrated dc voltage ranges; and a panel of miscellaneous testing circuits.

An oscilloscope and electronic switch are used in connection with the test panel. The latter makes it possible to put two variables on the scope simultaneously.

In addition, the usual portable test instruments are available for trouble-shooting in the field.

Robert (Bob) Towse assembles thermocouples. Note neat cables of tc wire.

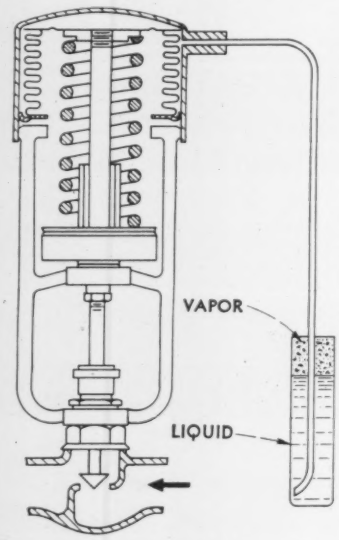


Fig. 13-1. Self-actuated temperature regulator. Set point can be adjusted by nut that compresses helical spring, but there is no sensitivity adjustment.

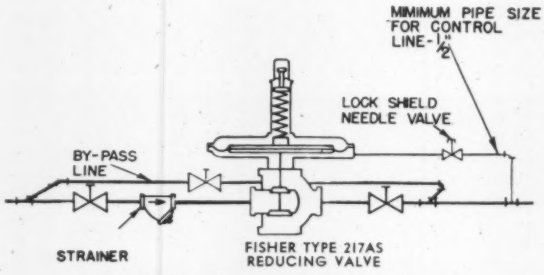


Fig. 13-2. Self-actuated pressure regulator and typical piping arrangement.

Contol Valves—No. 13

Control Valve or Regulator ?

IF CONFUCIUS had been an engineer he might have said, "He who uses simple instrument decreases headache and expense." Almost any instrument man knows of many an elaborate instrument control system—including pneumatic receiver, shaped valve characteristic and valve positioner, too—that has been installed but never used—because some simple device, like a pressure regulator, is doing the whole job alone—and adequately. The instrument engineer soon learns to use the least complex and most economical method of control for any specific application.

Basic Systems Available

There are three basic valve control systems in use—each of which is available with many modifications and unique features. However, all valve control systems in general use can be considered as one of the three following types, which are listed in increasing order of complexity:

1. Direct-acting or self-actuated *regulators*
2. Pilot-operated *regulators*
3. *Controllers* and control valves

The term "regulator" is applied to a control instrument that has no external source of power or operating medium—such as no source of air pressure. The term "controller" is used whenever the instrument has an external source of power.

In selecting a control system for any application, it is well to start by considering the simplest.

Direct-Acting Regulator

The direct-acting (self-actuated) regulator is the smallest and most economical valve control system available. Its main features are (1) small size, (2) economy, and (3) no external source of power required. Figs. 13-1, -2, and -3 show direct-acting regulators for temperature, pressure, and level.

The disadvantages of this type of control instrument—which determine when a more complex system must be used—are (1) lack of an adjustable proportional band, (2) lack of control refinements such as reset and rate actions, (3) adaptability mainly to pressure, temperature, and level problems.

Let us look at these limitations in detail. The average self-operated regulator can be considered a fixed-band proportional control device because the valve action is proportional to the change in controlled variable (one type is available also as on-off controller, and a few advanced types also have reset and rate actions).

The average regulator has a 25-50% proportional band, which is fixed—that is, it opens and closes on about 25 to 50% of the range that is available for control purpose. Because the sensitivity cannot be adjusted to meet

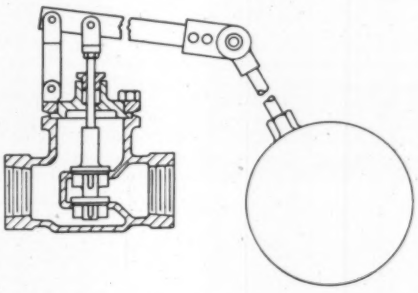


Fig. 13-3. Self-actuated level regulator.

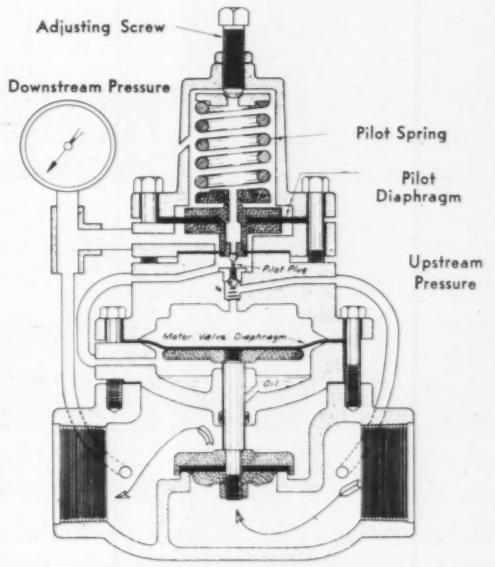


Fig. 13-4. Pilot-operated pressure regulator permits line pressure to operate main valve.

The simplest approach is often the best, and should be considered first. The simplest process control system is the self-actuated regulator; next is the pilot-operated regulator; then the controller. The advantages and limitations of each are discussed. This discussion concludes this basic and pioneering series on control valves, which will be made available in book form. Next: a series on regulators.

C. S. BEARD

Foster Engineering Company

varying load conditions, this type of system is used where the instrument is not required to maintain close control (say less than 1°F or 1 psi) over wide changes in pressure and/or temperature. Normal operating limits are about 300°F and about 600 psig—that is, a typical regulator will control steam temperature within 1°F in a 50- or 100-degree range up to 300°F, if the load demand is fairly constant. (The given ratings are the maximum found in literature. Most manufacturers stay below these values.)

The only adjustment available is the set point. Flexibility is obtained because of the wide variety of sizes and models available—that is, one model will vary steam flow by 30 pounds per hour for a 5° change in controlled temperature; another will vary steam flow by 60 pounds per hour for a 2° change in controlled temperature, etc.

As there are more industrial operations that take place below 300°F and 600 psig than above, and as most of these operations do not require close control over varying and wide limits of operation, there are more direct-acting self-operated regulators in use than all other types. Such applications include: steam supplies to heating equipments, hot water heaters, plating tanks, bottle washers, degreasers, fuel oil heaters, ovens, gas pressure regulators on gas laterals to houses and other buildings, water temperature regulators in domestic and industrial services, welding gas tank discharge, pump suction relief, back pressure control on tanks and oil wells, hydraulic systems to presses and lifts, compressor and engine cooling systems, etc.

Level regulators of this type (Fig. 13-3) are used in cooling tower pit makeup, water storage make-up, seal box level, etc.

This wide degree of application emphasizes that the simplest approach should be considerd first. Where a change of a few degrees of temperature or a few pounds of pressure can be tolerated, and where load changes are not severe, the self-acting regulator should be considered first.

Pilot-Operated Regulator

When the self-acting regulator won't meet the needs of the process—for reasons which will be discussed—the next device to consider is the pilot-operated regulator.

In this type of instrument a pilot valve (actuated directly by the pressure, temperature, or level to be controlled) permits the line fluid or line pressure to load a piston or diaphragm to position the inner valve.

Fig. 13-4 shows an internal-pilot-operated pressure regulator, or reducing valve. The inner main valve is controlled by a diaphragm. The inlet pressure can reach

the volume above this diaphragm only via the small pilot valve. The pilot valve is itself positioned by a diaphragm which is spring loaded on top and which receives the outlet pressure on its bottom area. The adjusting screw connected to the loading spring controls the set-point loading adjustment. Once set, a change in outlet pressure will operate the pilot to keep the outlet pressure constant.

Valves in this category can be diaphragm-operated (as shown in Fig. 13-4) or piston-operated, single-seated or balanced.

Fig. 13-5 shows a pilot-operated temperature regulator. Fig. 13-6 shows pilot-operated "altitude" regulator which permits line pressure to maintain desired water head in a remote water tank.

The pilot-operated regulator usually can be used to advantage under the following circumstances:

1. *When the variable exceeds the range of a self-operated regulator.*

In general, the pilot-actuated regulator is considered when set pressures approach or exceed the following values:

Fluid	Nominal Valve Size	psig
Steam	Up to ¾"	275
	1", 1¼" and 1½"	125
Gas	Up to ¾"	250
	1" and 1¼"	200
	1½" and larger	125 (approx.)
Water	Up to ¾"	3000
	Up to 2"	2500
	Up to 8"	125 (approx.)

In the above tabulation, valve sizes up to 8" are included. It should be pointed out that self-operated regulators are not usually made in sizes larger than 6", which in itself is rare.

Pilot-operated temperature regulators usually are limited to operating temperatures less than 600°F.

2. *When it is necessary to control the variable more accurately than can be done with a self-actuated regulator.*

A pilot system should be considered whenever pressure must be kept at all times within 1 to 5% of the set point, despite wide changes in load. This is comparable to "controller" accuracy. Diaphragm-operated pressure regulators can, under proper operating conditions, control within closer limits than this figure—but high-pressure piston-operated regulators cannot be expected to hold the control much closer than 5%.

3. *When a characterized inner valve is used.*

Pilot operation allows greater valve travel than can be obtained with a self-actuated regulator. The inner valve (either plug or ported type) can be shaped to vary the relation between valve opening and flow rate. Although the valve travel is not as long as in the control valve designed for use with an instrument controller, control often can be improved with a valve which causes a slow rate of change at low flows, with a linear change through the last half of its travel.

4. *When there is need to change the set point from a remote location.*

Centralized control need not preclude the use of a regulator. Pressure control from a remote loading regulator may replace the spring and adjusting screw. Normally, a relationship exists between the controlled pressure on one side of the pilot diaphragm and the loading pressure on the other side. This limits the ratio of the set pressure to the pressure available for loading. Use of a double-diaphragm head to operate the internal pilot valve makes possible a multifold increase or reduction of the ratio between loading pressure and set pressure in proportion to the ratio of the areas of the two diaphragms.

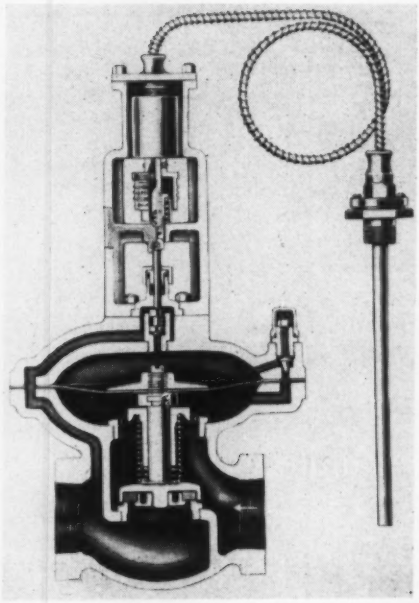


Fig. 13-5. Pilot-operated temperature regulator permits line pressure to operate main valve.

5. *When there is no pneumatic supply available.*

The pilot system makes use of line fluid to position the valve. Use of this motivating medium simplifies the system by eliminating pneumatic distribution lines and operating lines from the controller.

Where is a Controller Required?

The term "controller" applies to any control instrument that uses an external source of power to position the valve. This includes simple control pilots as well as complicated instruments.

Fig. 13-7 shows the simplest type of controller—often called a "pilot controller." Here the pilot is controlled by the variable, but the output of the pilot is a pneumatic signal obtained from a separate source of air. The basic characteristic of the controller, made possible by use of the external source of power, is adjustable sensitivity (proportional band). Refinements to the controller can be added as desired—reset, rate action, etc.

Use of a controller is usually (but not always) indicated:

1. *When the value of the controlled variable is beyond the range of a pilot system.*

Regulators will control steam with pressures as high as 1500 psig, and gases and water to at least 175 psig or temperatures up to 300°F. Higher values usually require use of a controller.

2. *When the variable is other than temperature, pressure, or level.*

Whereas conventional pneumatic controllers are designed to receive signals from pickups that are sensitive to any industrial variable, most regulators are designed

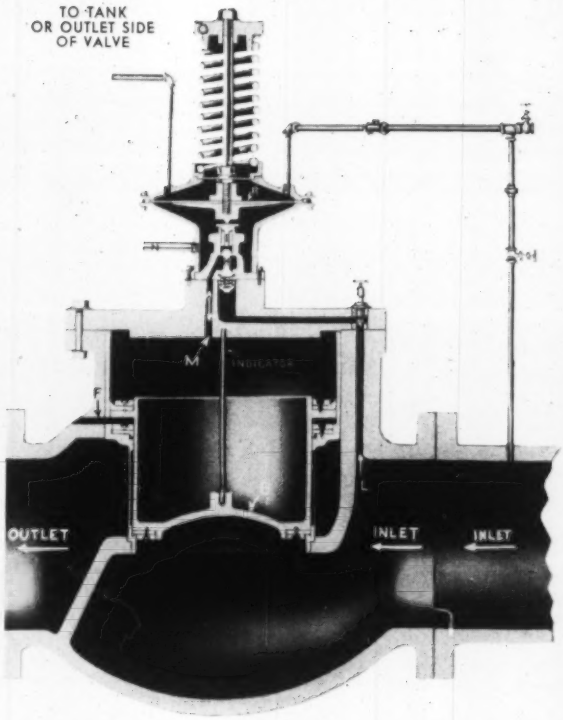


Fig. 13-6. Pilot operated "altitude" regulator permits line pressure to operate inner valve to maintain level in water tank.

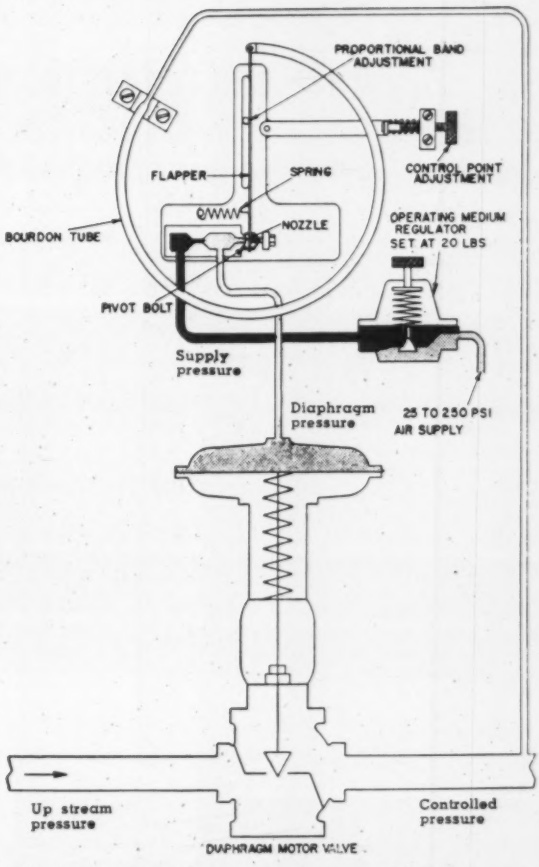


Fig. 13-7. Controller-type instruments differ from regulators in having a source of auxiliary power (air) with which to position the control valve. This makes possible adjustable proportional control and other control actions. Controller shown is simple controller type with proportional-band adjustment.

for use on temperature, pressure, or level. Control of the level of an interface between two liquids is also a type of application requiring a controller.

3. *When there is need for closer control than can be obtained from a regulator system.*

The pilot-controlled regulator usually can not control pressure within 1% of the control setting.

4. *When the control application requires wide proportional band, automatic reset, and/or derivative action.*

Most self-actuated regulators and pilot-actuated regulators have narrow throttling range, resulting in high sensitivity to changes. When the process being controlled has appreciable dead time, it becomes necessary to use a wider proportional band for stability. As the proportional band is widened, the deviation from the original set point becomes greater for a given change in operating conditions. Thus reset (integral response) may be required. Rate, or derivative response, which accelerates the corrective action of an actuator, also may be required in some processes. Many processes must have one of the following three common control actions: (1) Proportional plus reset, (2) proportional plus rate, (3) proportional plus reset plus rate.

When these actions are required, an instrument controller is indicated. Level control often requires a wide proportional-band action and, therefore, a controller.

5. *When the control instrument is mounted on a remotely located board.*

Placing a controller in a sheltered spot makes it possible to service the instrument under severe weather conditions. Nevertheless, there has been a trend toward having controllers mounted close to, or on, the valve. In this case, recorded or indicated intelligence may be transmitted to the board. Transmission lags in the control system can be cut down by using a transmitter plus a locally mounted controller.

6. *When there is need for cascaded control.*

In this form of instrumentation the output of one controller is used to reset another controller.

7. *When the available pressure drop across a control valve is insufficient for use of pilot-actuated regulators.*

The pilot-operated regulator requires 10- or 20-psi pressure differential across the seat, depending on the valve model. There may not even be this much pressure in the system. It should be remembered that good control through normal rangeability (operating limits) requires that the pressure differential be at least half as great as the combined pressure drops in the piping and equipment. Under any condition, it is difficult to obtain good control with a pilot-operated or self-actuated regulator if the pressure drop through the valve is less than 3 psi.

New Standard for Surface Roughness, Waviness, and Lay

DAN V. KELLY*
General Motors Corp.

A new standard for Surface Roughness, Waviness, and Lay, ASA B46.1—1955 has been approved by the American Standards Association. The sponsors are the Society of Automotive Engineers and The American Society of Mechanical Engineers.

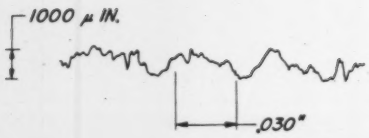


Fig. 1. Contour of a section normal to the surface of a machined surface.

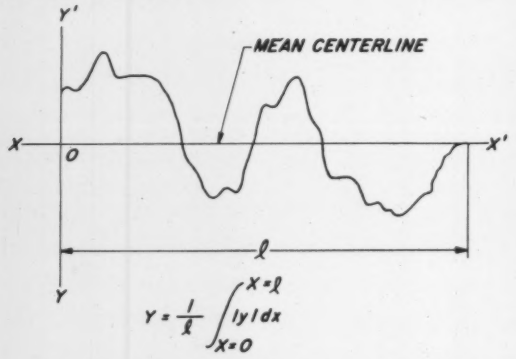


Fig. 2. The roughness-height rating of a surface relates the arithmetic average of the deviation from a mean centerline.

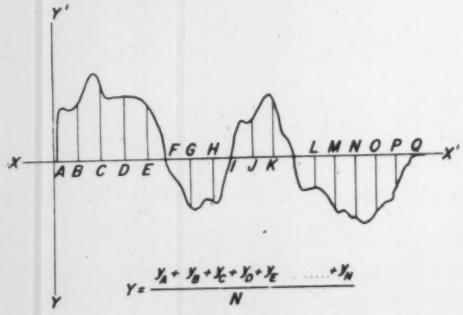


Fig. 3. Arithmetic average can be approximated by this simple technique.

CONTOUR of a section normal to a surface of a machined surface is shown in Fig. 1. Note that the horizontal scale is compressed by a factor of approximately 15 over the vertical scale to enable one to show vertical variations of the order of microinches over surface lengths of fractions of an inch to inches.

A few definitions with regard to surface irregularities are now in order. These definitions are taken from those given in the Standard.

Roughness

Roughness constitutes "those finely spaced surface irregularities, the height, width, and direction of which establish the predominant surface pattern." The roughness-height rating of a given surface is an average figure. Specifically it is the arithmetical average, in microinches, of the deviation of the surface from a mean centerline.

Fig. 2 expresses this relation mathematically. Applying the definition to a hypothetical surface profile, we can use the approximation shown in Fig. 3.

In the past, most specifications of surface-roughness-height have been in microinches, rms—that is, an average figure which is equal to the square root of the mean square of the deviations of a surface profile from a mean centerline.

The practical significance of the change in average is slight. A surface measured by available instruments calibrated in terms of arithmetical average will read precisely nine tenths of the numerical value which would be obtained if these instruments were calibrated to read in terms of rms average. This 10% change in numerical value is small compared to the point-to-point variation in average roughness height existing on all practical surfaces.

The explanation lies in the design of the instrumentation. Until recently, almost all instruments built and sold in this country indicated in proportion to the simple average of their input, but were calibrated to read the rms average value of a sine wave. When an instrument is calibrated in conformance with the present standard,

*Abstracted from ASME Paper 56—SA—48.

it is adjusted to read the arithmetical average of a sine-wave input. The arithmetical average of a sine wave is precisely nine tenths of the rms average. Hence, the numerical value obtained from any surface by the arithmetical average instrument will be 90% of the numerical reading obtained with an rms calibration.

Waviness

Waviness constitutes "those irregularities of the nominal surface which are of greater spacing than roughness." Waviness height is measured in inches as peak-to-valley distance. Waviness width is measured in inches.

Roughness-Width-Cutoff

Obviously there must be a limit or dividing line to separate roughness from waviness. In the past this limit, defined as the roughness-width-cutoff, has unofficially been taken to be 0.030", since most of the instruments in use included only irregularities of 0.030" or less in their roughness-height average. The Standard provides that the roughness-width-cutoff must be selected from the series, 0.003", 0.010", 0.030", etc. However, when no specific value is specified, the value 0.030" is assumed.

Lay

"The direction of the predominant surface pattern" is defined as the lay of the surface. The lay is usually determined by the machining method used, such as turning, surface grinding, shaping, or Blanchard grinding.

Symbol

The symbol used in roughness designation is defined as that shown in Fig. 4. The point of the check mark contacts the line designating the surface. The number "63" designates that the high limit of the surface is 63 microinches arithmetical average. The low limit is 32 microinches. If a high limit only (63 microinches) is desired, just the upper number, 63, is used. Reference to the Standard should be made for cases wherein additional information is shown by the symbol.

The Standard shows in detail means of using the symbol where it is not possible or feasible to have the symbol directly in contact with the line designating the surface.

Tracer-Type Instruments

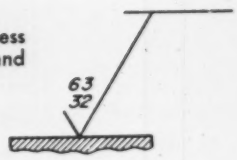
Many means of providing a surface-roughness-height rating have been suggested and devised. The only instrument in widespread use today is the tracer type—that is, an instrument which traverses a stylus of small tip radius across the surface. The vertical motion of the stylus is electronically amplified and made to actuate an indicating meter, from which average roughness-height is read directly (Fig. 5).

Instrument Specifications

The instrument is broken down into two basic areas—that part of the instrument which determines what surface information is included in the instrument reading and what information is excluded, and that part of the instrument which handles the admitted information and displays the resultant measurement.

The first area concerns the stylus, the tracer supports, the length of traverse of the stylus or sampling length, the speed of traverse or tracing speed, and the frequency response limits of the amplifier.

Fig. 4. Symbol for roughness designation gives the high and low limits.



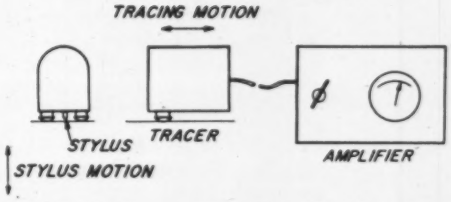


Fig. 5. Basic tracer-type instrument for measuring surface-roughness-height rating.

Stylus

It has been found experimentally that stylus radii of greater than 500 microinches exclude irregularities which contribute significantly to the surface-roughness-height measurement on practical surfaces. Radii of smaller value decrease the ruggedness of the stylus tip and increase the propensity of scratching the surface to be measured. Hence a preferred stylus radius of 500 microinches is called out by the Standard. Under unusual circumstances other radii may be used but should be selected from the series 100, 500, 5000, 50,000, etc. microinches.

Other stylus specifications are that the stylus is to be cone-shaped with the spherical tip tangentially connecting to the cone. The shank or cone angle is to be 90 deg. The stylus force is not to exceed a maximum of 2.5 grams for a 500-microin-radius tip. For other radius values the maximum allowable force varies as the square of the radius. The intent here is to set a maximum unit pressure regardless of the stylus radius.

Tracer Supports

The radius of the skids which support the tracer must be large enough so that the vertical motion of the tracer body itself will not add to or subtract from the motion of the stylus. The Standard states that the skid radius must be at least 8 times the roughness-width cutoff used for the measurement.

When it is necessary to measure roughness on surfaces of limited extent or on edges, slots, holes, or gear teeth, there usually is not room for skids. In this case, the stylus is attached to the end of the beam and the tracer is supported on reference slides.

Sampling Length

In order for the indicator to have sufficient time to arrive at its final value, the length of trace should be considerably greater than the roughness-width-cutoff. The Standard says that the minimum length should be 20 times the roughness-width-cutoff. For a roughness reading including irregularities up to 0.030" wide, the minimum sampling length is 0.6".

Tracing Speed and Frequency-Response Limits of Amplifier

The Standard does not attempt to determine a particular tracing speed; this is the province of the instrument manufacturer. But since the tracing speed and frequency-

response limits of the amplifier are directly concerned with the irregularity widths of the surface variations that are included in the roughness height average, a combination specification is provided.

Frequency Response

The output indicator should provide a constant output within 10% for a constant-amplitude, sinusoidal, mechanical input to the tracer, at any frequency within the pass-band.

At frequencies below the long-wavelength-cutoff frequency, the minimum attenuation rate should be at least 12 decibels per octave.

At frequencies above the short-wavelength-cutoff frequency, the attenuation rate may fall off in any manner in keeping with good instrument design, the only restriction being that the response should not rise above the normal (midband) gain.

Ballistics and Scale

The ballistic characteristics of the indicator are of importance. The limitation stated by the Standard is that the time required for 95% of full-scale deflection is 0.5 sec or 10/f sec, whichever is the greater (f is the frequency in cycles per second corresponding to the roughness-width-cutoff). The damping is specified to be 0.6 critical or more.

The remaining indicator specifications are that it be linear over the upper 80% of its scale and that it read directly in microinches, arithmetical average.

Over-All Accuracy

The indication of the instrument to a mechanical input of known amplitude within the amplitude and frequency range of the instrument shall not deviate by more than 10% from the true average value of the input.

Interrelation of Parameters

The final selection of a combination of values of stylus force and tip radius, stylus mass, tracing speed, frequency response, and gain of the amplifier, which provide a means of measuring the complex systems of profiles produced by all types of production methods, is an excellent illustration of the basic engineering fact that successful solution is the result of the compromise of many opposing but interrelated factors.

Physical Specimens

Specifications are written for Precision Reference Specimens and Roughness Comparison Specimens. The former are used for checking performance and calibration of tracer-type instruments. Appendix C of the Standard provides a step-by-step method of using the Precision Reference Specimens for measuring stylus radius. The Roughness Comparison Specimens are of use in the engineering department and drafting room. They are also of value in providing an approximate rating of roughness on machine parts by tactile comparison.

The appendixes of the Standard provide background on the use and interpretation of tracer-type instruments and also some general thoughts on surface-finish control.

Automatic Oswald Viscosimeter

This Oswald-type viscosimeter uses a photoelectrically triggered timing device to measure the time for a controlled volume of liquid to flow through a capillary.

GEORGE GOLDFINGER* and **WILSON GREATBATCH**
University of Buffalo

As an Oswald viscosimeter was being used in an inaccessible place, a phototransistor device was built to indicate passage of the liquid past checkmarks. This photoelectric device proved so successful that it is now used exclusively for flow-viscosity measurements in this laboratory.

Description of Viscosimeter

The viscosimeter is jacketed to permit circulation of controlled-temperature water around it. A bulb (Fig. 1) defines a volume of liquid that flows through the capillary during the measured time interval, this time being a measure of the viscosity of the fluid. The bulb is blown between two short lengths of capillary tubing. On each short length of tubing (above and below the bulb) two glass tubes are blown at right angles to the direction of flow. These tubes (Fig. 1.B) are fused to the outside on opposite sides of the capillaries, with no connection between the capillary core and these tubes. At the top and bottom of the measuring bulb a light bulb is placed opposite a phototransistor, as shown in

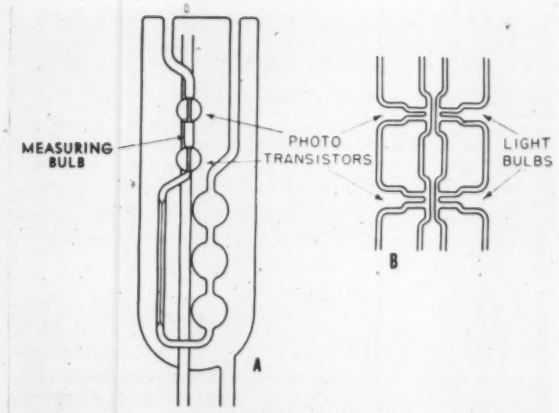


Fig. 1. (A) Jacketed viscosimeter encloses a measuring bulb blown between two short lengths of capillary tubing. (B) Two paths of light, one above and one below the measuring bulb, define the upper and lower limits of the measured volume.

*Present Address: Armour Research Foundation, Chicago, Illinois

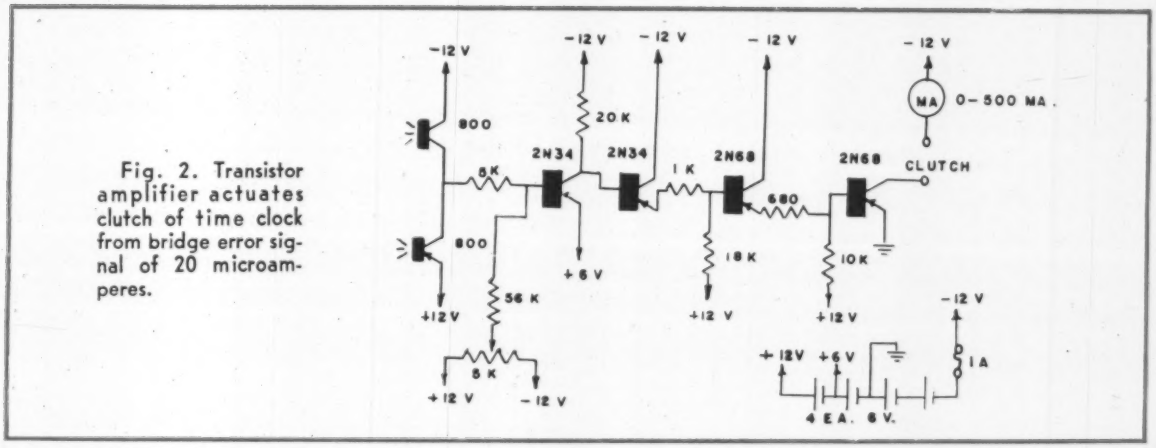


Fig. 2. Transistor amplifier actuates clutch of time clock from bridge error signal of 20 microamperes.

Fig. 1.B. This defines the upper and lower limits of the measured volume.

The capillary tube acts as a cylindrical lens that focuses the light from the bulb on the opposite phototransistor. When the capillary is filled with benzene, the light intensity at the phototransistor is as much as four times greater than when the capillary is empty.

Description of Transistor Circuits

The two phototransistors are arms of a voltage-dividing bridge circuit connected to a high-gain transistor current amplifier (Fig. 2). The current amplifier delivers a d-c output (6.0 v at 0.4 amp) to actuate the solenoid clutch of a synchronous-motor clock (Standard Electric Time Corporation, Model SW-1, 60 cps). The clutch mechanism has a rated maximum error of ±1 millisecond.

The phototransistor bridge consists of the two phototransistors in series (Texas Instruments, Inc., No. 800) across a 24-v d-c bridge supply (±12v). The bridge error signal is taken between the junction of the two phototransistors and the mid-tap on the ±12-volt battery. When there is fluid between the bulbs and phototransistors, the resistance of each phototransistor is approximately the same because the illumination level at each is equal (and high). Any difference in resistance due to difference in phototransitor characteristics is balanced out by the 5K variable bias adjustment.

Table 1.—Flow Time of Benzene at 20°C

Flow Time (seconds)				
	Group of Five		All Groups	
Total	Average	Deviation	Average	Deviation
88.039		0.008		0.009
88.023		0.008		0.007
88.028		0.003		0.002
88.036		0.005		0.006
88.030	88.031	0.001		0.000
88.018		0.012		0.012
88.023		0.007		0.007
88.044		0.014		0.014
88.040		0.010		0.010
88.023	88.030	0.007		0.007
88.024		0.006		0.006
88.016		0.014		0.014
88.046		0.016		0.016
88.037		0.007		0.007
88.028	88.030	0.002	88.030	0.002
				±0.008

When the liquid begins to flow out of the measuring volume, the illumination level on the upper phototransistor decreases and its resistance increases. The bridge is then unbalanced, causing hole current flow. This hole current flow, when amplified, actuates the clutch solenoid and starts the clock. When the liquid meniscus passes the second phototransistor its illumination level decreases. This rebalances the bridge and stops the clock.

The first stage of the amplifier is a high-gain, grounded-emitter amplifier (2N34), and is followed by two cascaded grounded-collector stages (2N34 and 2N68). The last stage is a ground-emitter power amplifier (2N68). Reliable clutch operation has been obtained with bridge error signals of as little as 2 microamperes.

Temperature effects on transistor operation are not a problem because the phototransistor bridge is enclosed in a temperature-controlled environment. As little heat is developed in the current amplifier, the high-gain input stage is not adversely affected over the short time that operating point stability must be maintained.

The response time of the viscosimeter (the time between light-intensity change at the phototransistor and clutch-current change) is estimated from circuit theory considerations to be about 10^{-4} sec.

Sample Runs

Three groups of five runs each are reported in Table 1, in which flow times of 88 seconds are reproduced to within ±0.005, ±0.010, and ±0.009 second. The shortest time measured is 88.016 seconds, and the longest 88.046 seconds; a difference of 0.030 second. These measurements were carried out at 20°C jacket temperature. During the runs, fluctuations of ±0.01 C° were read on the Beckman thermometer in the viscosimeter jacket. As temperature affects the viscosity of benzene, and hence its flow time, variations of 1% change in flow time per centigrade degree change in temperature are expected in the vicinity of 20°C. Hence the fluctuations of the observed flow time are to be expected from observed temperature fluctuations.

Conclusion

The instrument described can be used to measure viscosities at least ten times more accurately than is possible manually. A small amplifier driving an electronic counter would provide a more elegant instrument, but present system accuracy is already limited by considerations other than those associated with the time measuring system. Present accuracy could be increased by improving the time measuring and temperature-control equipment.

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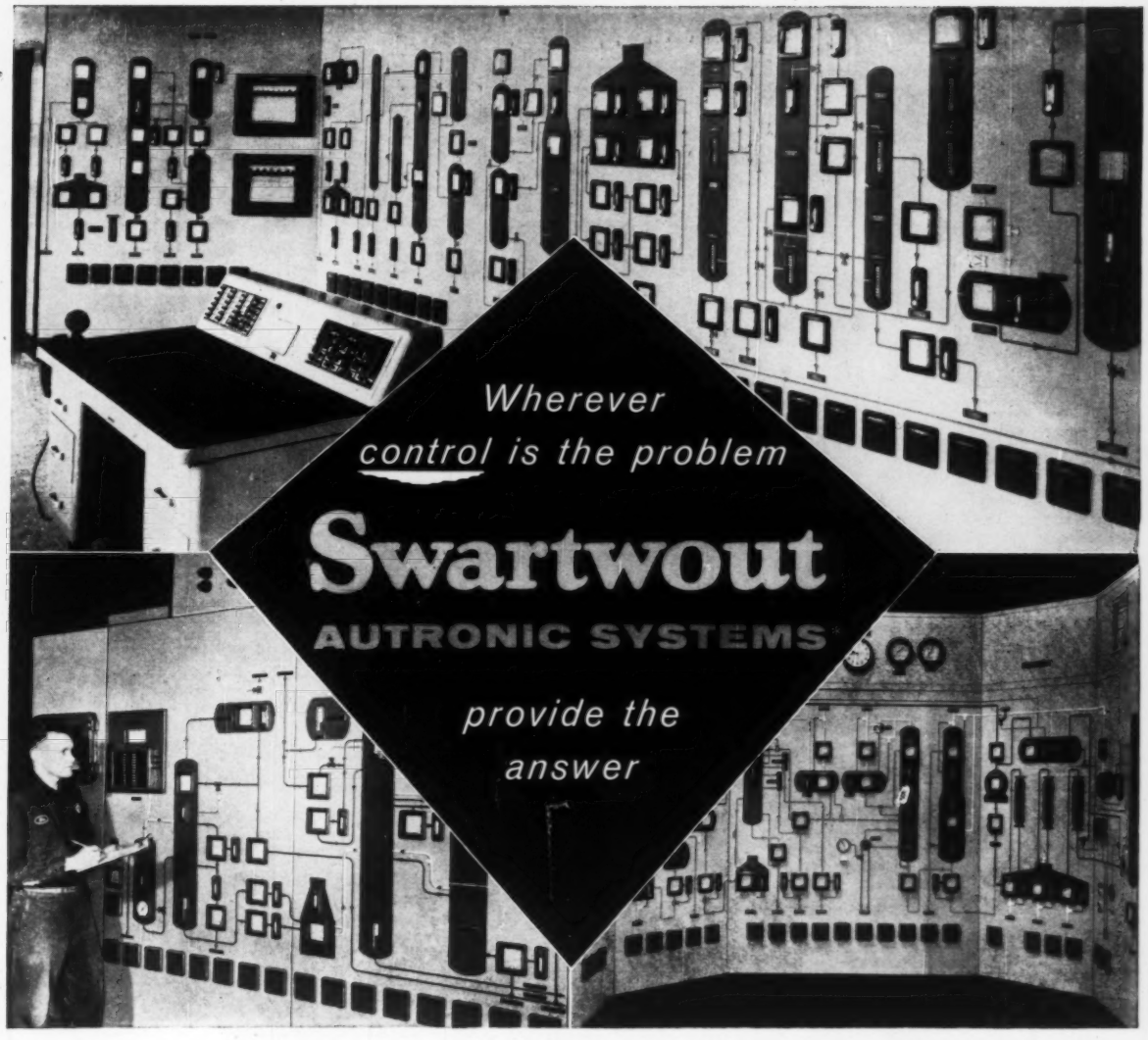

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Journal of the S C M A . . .

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The S.C.M.A. Handbook

ONE of the main purposes of the Southern California Meter Association, as originally conceived, was to compile a booklet of systematically arranged information pertaining broadly to fluid meters, instruments or controllers, and publish the same over the name of the Association.

This the Association has done for the last 25 years. The book has been widely used by Engineers and field men in the gas and oil industries. The range of material covered is indicated by the sample index and data sheets shown here.

The handbook sells for $7.50 to members of the Association and $10.-00 to non-members. Inquiries should be directed to the Secretary of the S.C.M.A.

DATA FOR CHANGING SIZE OF ORIFICE PLATES

Square Root Charts

Field calculation of new coefficients for metering a given flow at constant pressure under new metering conditions.

Orifice sizes to be used are determined from new coefficients where:

$$C_2 = C_1 \times \frac{h_{s_1}}{h_{s_2}} \times \frac{M_1}{M_2}$$

C_1 = Coefficient for original plate size and type of connection in use.
C_2 = Coefficient for desired condition
h_{s_1} = Differential reading of square root chart at original condition
h_{s_2} = Differential reading of square root chart at desired condition
M_1 = Square root chart factor for original gauge
M_2 = Square root chart factor for new gauge

Table I $\left(\frac{h_{s_1}}{h_{s_2}}\right)$

h_{s_1} \ h_{s_2}	1	2	3	4	4.5	5	5.5	6
1	1.000	.500	.333	.250	.222	.200	.182	.167
2	2.000	1.000	.667	.500	.444	.400	.364	.333
3	3.000	1.500	1.000	.750	.667	.600	.545	.500
4	4.000	2.000	1.333	1.000	.889	.800	.727	.667
4.5	4.500	2.250	1.500	1.125	1.000	.900	.818	.750
5.0	5.000	2.500	1.667	1.250	1.111	1.000	.909	.833

Table II $\left(\frac{M_1}{M_2}\right)$

Original Range		Desired Range					
" water	M_1	10	20	50	60	100	200
		M_2					
		.3162	.4472	.7071	.7746	1.0000	1.4142
10	.3162	1.000	.707	.447	.408	.316	.224
20	.4472	1.414	1.000	.632	.577	.447	.316
50	.7071	2.236	1.581	1.000	.913	.707	.500
60	.7746	2.450	1.732	1.095	1.000	.775	.548
100	1.0000	3.163	2.236	1.414	1.291	1.000	.707
200	1.4142	4.472	3.162	2.000	1.826	1.414	1.000

Example:
A 100" gauge gives a square root chart differential reading of 2 with a 10" x 5.000 plate - Flange taps.
Find what size plate will be required with a 10" gauge for a differentia reading of 7 with (a) Pipe taps (b) Flange taps

$\frac{h_{s_1}}{h_{s_2}} = \frac{2}{7}$ from table I = .286

$M_1 = 1.000$
$M_2 = .3162$
$\frac{M_1}{M_2} = \frac{1.0000}{.3162}$ from table II = 3.163

$C_1 = .5245$ (from data sheet 194)
$C_2 = .5245 \times .286 \times 3.163 = .4745$

(a) This corresponds to a 10" x 4.500 for pipe taps (data sheet 200)
(b) This corresponds to a 10" x 4.750 for flange taps (data sheet 194)

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SECTION ONE

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207	Temperature Factors (F_T)
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210	Beta Factors
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Gas Flow General

1

SECTION FIVE

MEASUREMENT OF LIQUID FLOW

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Liquid Flow

5

PHYSICAL CONSTANTS OF LIGHT HYDROCARBONS AND MISCELLANEOUS COMPOUNDS

REVISED - DEC. 1953

COMPOUND	FORMULA	MOLECULAR WEIGHT	MELTING POINT 760 mm		NORMAL BOILING POINT 760 mm		CRITICAL DATA			LIQUID DENSITY 760 mm - 60°F				LIQUID COEF. OF EXPANSION PER °F - RANGE 50° - 100° F	GAS DENSITY DATA 760 mm - 60°F "PERFECT GAS"				DEVIATION FACTOR 60°F	SPECIFIC HEAT DATA 760 mm - 60°F				LATENT HEAT B T U PER LB AT 760 mm AND BOILING POINT	GROSS HEATING VALUE 760 mm - 60°F		VAPOR PRESSURE PSIA 100°F
							PRESS. LB. PER SQ. IN. A	TEMPERATURE		SP. GR. 60/60	°API	LBS/GAL.	GALS/LB. MDL.		SPEC. GRAV. AIR = 1.00	LB. PER M.C.F.	CUBIC FEET OF GAS PER GAL. OF LIQUID	UNIT VOL. OF GAS PER UNIT VOL. OF LIQUID		C_p	C_v	C_p/C_v	LIQUID		BTU/LB.	BTU/CU.FT.	
			°F	°C	°F	°C		°F	°C																		
METHANE	$C H_4$	16.042	-296.5	-182.5	-258.7	-161.5	673	-116.5	-82.5	.3	340.0	2.5	6.4	.00204	0.554	42.27	59.00	442	1.0020	.5271	.402	1.308	-	219.7	23.891	1.010	-
ETHANE	C_2H_6	30.068	-297.9	-183.3	-127.5	- 88.6	708	90.1	32.3	.374	297.0	3.11	9.67	.00208	1.038	79.23	39.25	293.6	1.008	.4097	.342	1.193	- "	210.7	22.329	1.769	790 EXTRAPOLATED
PROPANE	C_3H_8	44.094	-305.8	-187.7	- 43.7	- 42.0	617	206.3	96.8	.50775	147.2	4.226	10.44	.00180	1.522	116.19	26.35	271.9	1.016	.3885	.342	1.133	.536 @ 43° F	183.5	21.670	2.518	190.
ISO - BUTANE	C_4H_{10}	58.120	-255.3	-159.5	10.9	- 11.7	529	275.0	135.0	.56315	113.8	4.685	12.40	.00128	2.006	153.15	30.59	228.8	1.030	.3872	.352	1.097	.537 @ 14°F	157.8	21.265	3.256	72.2
N - BUTANE	C_4H_{10}	58.120	-212.0	-138.3	31.1	- 0.5	551	305.6	152.0	.58443	110.6	4.863	11.95	.00128	2.006	153.15	31.75	237.5	1.032	.3970	.363	1.094	.548 @ 0° F	165.9	21.315	3.284	51.6
ISO - PENTANE	C_5H_{12}	72.146	-255.8	-159.9	82.1	27.8	483	370.0	187.8	.6248	95.0	5.200	13.88	.00086	2.491	190.11	27.60	205.0	1.045	0.3880	.361	1.076	.532	145.9	21.046	4.001	20.4
N - PENTANE	C_5H_{12}	72.146	-201.5	-129.7	96.9	36.0	490	385.9	196.6	.6312	92.7	5.253	13.74	.00086	2.491	190.11	27.68	207.1	1.048	.3972	.370	1.074	.536	153.8	21.094	4.009	15.6
2,2-DIMETHYLBUTANE*	C_6H_{14}	86.172	-147.8	- 99.9	121.5	49.7	450.5	421.2	216.2	.654	84.9	5.44	15.84	-	2.975	227.1	24.01	179.6	-	.386	(.363)	(1.063)	-	131.4	20.747	4.735	9.86
2,3-DIMETHYLBUTANE*	C_6H_{14}	86.172	-199.4	-128.6	136.4	58.0	455.4	440.8	227.1	.666	80.8	5.55	15.52	.00078	2.975	227.1	24.47	183.1	-	.391	(.368)	(1.063)	-	136.3	20.779	4.744	7.40
2-METHYLPENTANE*	C_6H_{14}	86.172	-244.6	-153.7	140.5	60.3	440.1	436.8	224.9	.658	81.6	5.48	15.72	-	2.975	227.1	24.16	180.7	-	.389	(.366)	(1.063)	-	138	20.791	4.748	6.77
3-METHYLPENTANE*	C_6H_{14}	86.172	-180.4	-118.0	145.9	63.3	453.1	448.2	231.2	.669	80.0	5.57	15.47	-	2.975	227.1	24.56	183.7	-	.397	(.374)	(1.061)	-	140.3	20.804	4.751	6.10
N-HEXANE	C_6H_{14}	86.172	-139.6	- 95.3	155.7	68.7	440	454.5	234.7	.6640	81.6	5.527	15.59	.00075	2.975	227.07	24.38	182.4	1.066	.3984	.375	1.062	.552	144.2	20.949	4.756	4.96
N-HEPTANE	C_7H_{16}	100.198	-131.1	- 90.6	209.2	98.4	397	512.6	267.0	.6882	74.1	5.728	17.49	.00068	3.459	264.03	21.73	162.6	1.087	.3992	.379	1.052	.528	136.2	20.842	5.503	1.62
N-OCTANE	C_8H_{18}	114.229	- 70.2	- 56.8	258.2	125.7	362	565.2	296.2	.7068	68.7	5.883	19.41	.00064	3.943	300.99	19.58	146.5	1.100	.3998	.382	1.046	.523	131.9	20.784	6.250	0.54
N-NONANE	C_9H_{20}	128.250	- 64.4	- 53.6	303.4	150.8	345	613.0	322.8	.7217	64.6	6.008	21.35	.00062	4.428	337.95	17.80	133.2	1.120	.4003	.385	1.040	.522	126.9	20.701	6.996	0.18
N-DECANE	$C_{10}H_{22}$	142.278	- 21.5	- 29.7	345.2	174.0	320	655.0	346.1	.7341	61.3	6.114	23.27	.00059	4.912	374.91	16.32	122.1	1.140	.4006	.387	1.034	.520	120.2	20.653	7.743	0.07
BENZENE*	C_6H_6	78.108	41.96	5.53	176.2	80.1	714	553.01	289.5	.885	28.5	7.37	10.58	.00067	2.696	205.8	35.83	268.0	1.03	.2404	.2150	1.118	-	169.3	18.013	3.742	3.224
CYCLOHEXANE*	C_6H_{12}	84.158	43.80	6.55	177.3	80.7	561.4	536.0	281.2	.783	49.1	6.53	12.89	.00067	2.905	221.8	29.45	220.3	1.004	.2900	.2664	1.089	-	153.7	20.066	4.482	3.265
OXYGEN	O_2	32.000	-361.1	-218.4	-297.4	-183.0	730	-181.8	-118.8	1.1409	-	-	-	-	1.105	84.32	-	-	1.00075	.2188	.156	1.401	-	92	-	-	-
NITROGEN	N_2	28.016	-345.8	-209.8	-320.4	-195.8	492	-232.8	-147.1	.808#	- -	-	-	-	0.967	73.82	-	-	1.0003	.2482	.177	1.404	-	86	-	-	-
AIR	-	28.966	-	-	-317.7	-194.3	547	-221.3	-140.7	.856#	-	-	-	-	1.000	76.33	-	-	1.00039	.241	.171	1.410	-	92	-	-	-
CARBON MONOXIDE	CO	28.010	-337.0	-205.0	-312.7	-191.5	514	-218.2	-139.0	.801#	-	-	-	-	0.967	73.81	-	-	1.0004	.2484	.177	1.404	-	91	4,350	321	-
CARBON DIOXIDE	CO_2	44.010	-	-	-109.3(b)	-78.5(b)	1073	88.0	31.1	1.56 (Solid)	-	-	-	-	1.519	116.0	-	-	1.0058	.1991	.152	1.304	-	-	-	-	-
HYDROGEN SULFIDE	H_2S	34.076	-121.9	- 85.5	- 76.5	-60.3	1306	212.7	100.4	.790#	47.8	6.58	5.18	-	1.176	89.79	73.28	548.2	1.0110	.254	.192	1.320	-	236	7,480	680	554.6
WATER	H_2O	18.016	32	0	212.0	100.0	3206	705.4	374.1	1.000	10.0	8.328	2.16	-	0.622	47.47	175.44	1812.4	1.0095	.4446	.333	1.335	1.000	970	-	-	0.949

ACKNOWLEDGMENT:

All values obtained from the California Natural Gasoline Association's Bulletin TS-401, Second Edition, 1945, except those compounds marked with an asterisk. Values for these obtained from Natural Gasoline Supply Men's Association Technical Manual (Sixth Edition) April 1951.

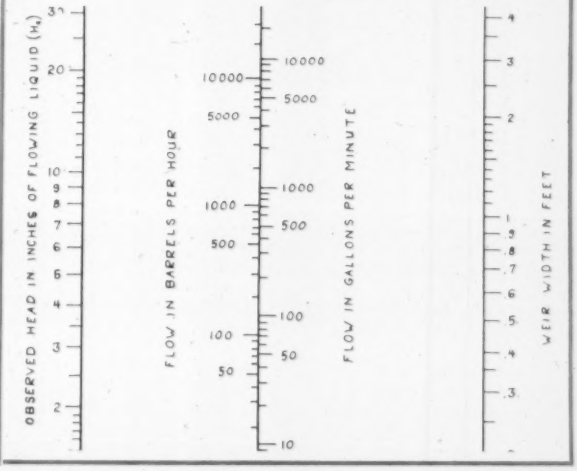
(a) - at 32°F (b) - Sublimes * - Liquid Density at Boiling Point

(a) - Saturated

TEMPERATURE FACTOR (L_T) A.S.T.M. ORIFICE METER TEMPERATURE CORRECTION FACTOR (L_T)

Observed Temperature °F.	Group 0 0-14.9° API	Group 1 15.0-34.9° API	Group 2 35.0-50.9° API	Group 3 51.0-63.9° API	Group 4 64.0-78.9° API	Group 5 79.0-88.9° API	Group 6 89.0-93.9° API	Group 7 94.0-100.0° API
	Group Number and API Gravity Range at 60°F.							
	Factor for Reducing Volume to 60°F.							
0	1.0105	1.0120	1.0148	1.0179	1.0207	1.0236	1.0247	1.0263
1	1.0104	1.0118	1.0145	1.0176	1.0204	1.0232	1.0243	1.0258
2	1.0102	1.0116	1.0143	1.0173	1.0200	1.0228	1.0239	1.0254
3	1.0100	1.0114	1.0141	1.0171	1.0197	1.0224	1.0235	1.0250
4	1.0098	1.0112	1.0138	1.0168	1.0194	1.0221	1.0231	1.0245
5	1.0097	1.0110	1.0136	1.0165	1.0191	1.0217	1.0227	1.0241
6	1.0095	1.0108	1.0133	1.0162	1.0187	1.0213	1.0223	1.0237
7	1.0093	1.0106	1.0131	1.0159	1.0184	1.0209	1.0219	1.0233
8	1.0091	1.0104	1.0128	1.0156	1.0180	1.0205	1.0215	1.0229
9	1.0089	1.0102	1.0126	1.0153	1.0177	1.0201	1.0211	1.0224
10	1.0088	1.0100	1.0123	1.0150	1.0173	1.0197	1.0207	1.0220
11	1.0086	1.0098	1.0121	1.0147	1.0170	1.0194	1.0203	1.0216
12	1.0084	1.0096	1.0118	1.0144	1.0167	1.0190	1.0199	1.0212
13	1.0082	1.0094	1.0116	1.0141	1.0163	1.0186	1.0195	1.0207
14	1.0081	1.0092	1.0113	1.0138	1.0160	1.0182	1.0191	1.0202
15	1.0079	1.0090	1.0111	1.0136	1.0156	1.0178	1.0187	1.0198
16	1.0077	1.0088	1.0108	1.0132	1.0153	1.0174	1.0183	1.0194
17	1.0075	1.0086	1.0106	1.0129	1.0149	1.0170	1.0178	1.0190
18	1.0074	1.0084	1.0104	1.0126	1.0146	1.0167	1.0174	1.0185
19	1.0072	1.0082	1.0102	1.0123	1.0142	1.0163	1.0170	1.0181

MEASUREMENT OF NONVISCOUS LIQUIDS BY RECTANGULAR WEIRS WITH COMPLETE CONTRACTIONS



PROPERTIES OF MERCURY

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Symbol	Hg
Specific Gravity	13.59 (Water @ 4° C)
Weight, lbs./cubic foot	848
Atomic Weight	200.61
Melting Point	-38° F.
Boiling Point	674° F @30" Hg absolute
	658 25
	636 20
	572 10
	520 5
Cubical Coefficient of Expansion/Degree F.	.000101
Vapor Pressure @ 70° F.	.0013 mm. Hg
	.00005118 inches Hg
	.000025 lbs./sq. inch
Specific Heat Btu/lb./Deg. F.	.03
Pressure Conversion Factors:	1" Hg = 13.59" water
	= 1.133 Feet of Water
	= .4912 lbs./sq. in.

Mercury will evaporate at ordinary temperatures if left in an open vessel, and since its vapors are very poisonous, it should always be covered. Small amounts spilled on the bench or floor should be picked up. In the cleaning by distillation, care must be taken that vapors do not escape.

Antidotes for Mercury Poisoning:

(1) White of egg in water
(2) Emetic or use stomach pump
(3) Milk or thin starch paste
(4) Stimulate and combat collapse

Platinum and iron are the only metals not affected by mercury. It will amalgamate in varying degrees with all other metals.

RECOMMENDED SIZES FOR ORIFICE METERS

Flange Taps

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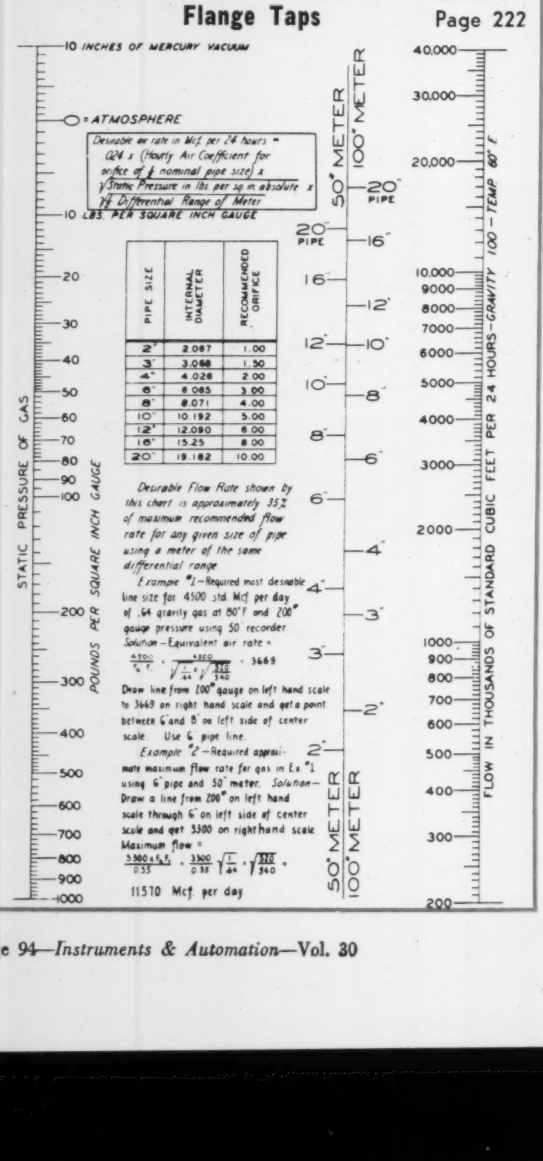

PIPE SIZE	INTERNAL DIAMETER	RECOMMENDED ORIFICE
2"	2.067	1.00
3"	3.068	1.50
4"	4.026	2.00
6"	6.065	3.00
8"	8.071	4.00
10"	10.192	5.00
12"	12.090	6.00
16"	15.25	8.00
20"	19.182	10.00

Desirable Flow Rate shown by this chart is approximately 35% of maximum recommended flow rate for any given size of pipe using a meter of the same differential range.

Example "1—Required most desirable line size for 4500 std. Mcf per day of .64 gravity gas at 80° F and 200" gauge pressure using 50 recorder. *Solution*—Equivalent air rate = $\frac{4500}{\frac{1}{2}} \times \frac{\sqrt{.64}}{\sqrt{\frac{1}{2}}} \times \frac{\sqrt{540}}{\sqrt{540}} = 3669$

Draw line from 200" gauge on left hand scale to 3669 on right hand scale and get a point between 6" and 8" on left side of center scale. Use 6" pipe line.

Example "2—Required approximate maximum flow rate for gas in Ex. "1 using 6" pipe and 50" meter. *Solution*—Draw a line from 200" on left hand scale through 6" on left side of center scale and get 3300 on right hand scale. Maximum flow = $\frac{3300 \times \frac{1}{2}}{0.35} \times \frac{3300}{0.35} \sqrt{\frac{1}{.64}} \times \sqrt{\frac{200}{540}} \times$

11570 Mcf. per day

TEMPERATURE FACTORS

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Multiply observed volume at temperature indicated by factors shown below to obtain corresponding volume at 60°F

Observed Temperature, °F.	Group 0	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
	0-14.9° API	15.0-34.9° API	35.0-50.9° API	51.0-63.9° API	64.0-78.9° API	79.0-88.9° API	89.0-93.9° API	94.0-100.0° API
	Factor for Reducing Volume to 60° F.							
0	1.0211	1.0241	1.0298	1.0362	1.0419	1.0478	1.0501	1.0532
1	1.0206	1.0237	1.0293	1.0356	1.0412	1.0470	1.0493	1.0523
2	1.0204	1.0233	1.0288	1.0350	1.0405	1.0462	1.0484	1.0514
3	1.0201	1.0229	1.0283	1.0344	1.0399	1.0454	1.0476	1.0506
4	1.0197	1.0225	1.0278	1.0338	1.0392	1.0446	1.0468	1.0497
5	1.0194	1.0221	1.0273	1.0332	1.0385	1.0438	1.0460	1.0488
6	1.0190	1.0217	1.0268	1.0326	1.0378	1.0430	1.0451	1.0479
7	1.0186	1.0213	1.0263	1.0320	1.0371	1.0423	1.0443	1.0470
8	1.0183	1.0209	1.0258	1.0314	1.0364	1.0415	1.0435	1.0462
9	1.0179	1.0205	1.0253	1.0308	1.0357	1.0407	1.0427	1.0453
10	1.0176	1.0201	1.0248	1.0302	1.0350	1.0399	1.0418	1.0444
11	1.0172	1.0197	1.0243	1.0296	1.0343	1.0391	1.0410	1.0435
12	1.0169	1.0193	1.0238	1.0290	1.0336	1.0383	1.0402	1.0427
13	1.0165	1.0189	1.0233	1.0284	1.0329	1.0375	1.0393	1.0418
14	1.0162	1.0185	1.0228	1.0278	1.0322	1.0367	1.0385	1.0409
15	1.0158	1.0181	1.0223	1.0272	1.0315	1.0359	1.0377	1.0400
16	1.0155	1.0177	1.0218	1.0266	1.0308	1.0351	1.0369	1.0391
17	1.0151	1.0173	1.0214	1.0260	1.0301	1.0343	1.0360	1.0383
18	1.0148	1.0168	1.0209	1.0253	1.0294	1.0336	1.0352	1.0374
19	1.0144	1.0164	1.0204	1.0247	1.0287	1.0328	1.0344	1.0365
20	1.0141	1.0160	1.0199	1.0241	1.0280	1.0320	1.0335	1.0356
21	1.0137	1.0156	1.0194	1.0235	1.0273	1.0312	1.0327	1.0347
22	1.0133	1.0152	1.0189	1.0229	1.0266	1.0304	1.0319	1.0338
23	1.0130	1.0148	1.0184	1.0223	1.0259	1.0296	1.0310	1.0330
24	1.0126	1.0144	1.0179	1.0217	1.0253	1.0288	1.0302	1.0321
25	1.0123	1.0140	1.0174	1.0211	1.0246	1.0280	1.0294	1.0312
26	1.0119	1.0136	1.0169	1.0205	1.0239	1.0272	1.0285	1.0303
27	1.0116	1.0132	1.0164	1.0199	1.0232	1.0264	1.0277	1.0294
28	1.0112	1.0128	1.0159	1.0193	1.0225	1.0256	1.0269	1.0285
29	1.0109	1.0124	1.0154	1.0187	1.0218	1.0248	1.0260	1.0276
30	1.0105	1.0120	1.0149	1.0181	1.0211	1.0240	1.0252	1.0268
31	1.0102	1.0116	1.0144	1.0175	1.0204	1.0232	1.0244	1.0259
32	1.0098	1.0112	1.0139	1.0169	1.0197	1.0224	1.0235	1.0250
33	1.0095	1.0108	1.0134	1.0163	1.0190	1.0216	1.0227	1.0241
34	1.0091	1.0104	1.0129	1.0157	1.0183	1.0208	1.0219	1.0232
35	1.0088	1.0100	1.0124	1.0151	1.0176	1.0200	1.0210	1.0223
36	1.0084	1.0096	1.0119	1.0145	1.0169	1.0192	1.0202	1.0214
37	1.0081	1.0092	1.0114	1.0139	1.0162	1.0184	1.0193	1.0205
38	1.0077	1.0088	1.0109	1.0133	1.0155	1.0176	1.0185	1.0197
39	1.0074	1.0084	1.0104	1.0127	1.0148	1.0168	1.0177	1.0188
40	1.0070	1.0080	1.0099	1.0121	1.0141	1.0160	1.0168	1.0179
41	1.0067	1.0076	1.0094	1.0115	1.0134	1.0152	1.0160	1.0170
42	1.0063	1.0072	1.0089	1.0109	1.0127	1.0144	1.0152	1.0161
43	1.0060	1.0068	1.0084	1.0103	1.0120	1.0136	1.0143	1.0152
44	1.0056	1.0064	1.0079	1.0097	1.0113	1.0128	1.0135	1.0143
45	1.0053	1.0060	1.0075	1.0091	1.0106	1.0120	1.0126	1.0134
46	1.0049	1.0056	1.0070	1.0085	1.0099	1.0112	1.0118	1.0125
47	1.0046	1.0052	1.0065	1.0079	1.0091	1.0104	1.0110	1.0116
48	1.0042	1.0048	1.0060	1.0073	1.0084	1.0096	1.0101	1.0107
49	1.0038	1.0044	1.0055	1.0067	1.0077	1.0088	1.0093	1.0099
50	1.0035	1.0040	1.0050	1.0061	1.0070	1.0080	1.0084	1.0090
51	1.0031	1.0036	1.0045	1.0054	1.0063	1.0072	1.0076	1.0081
52	1.0028	1.0032	1.0040	1.0048	1.0056	1.0064	1.0067	1.0072
53	1.0024	1.0028	1.0035	1.0042	1.0049	1.0056	1.0059	1.0063
54	1.0021	1.0024	1.0030	1.0036	1.0042	1.0048	1.0051	1.0054
55	1.0017	1.0020	1.0025	1.0030	1.0035	1.0040	1.0042	1.0045
56	1.0014	1.0016	1.0020	1.0024	1.0028	1.0032	1.0034	1.0036
57	1.0010	1.0012	1.0015	1.0018	1.0021	1.0024	1.0025	1.0027
58	1.0007	1.0008	1.0010	1.0012	1.0014	1.0016	1.0017	1.0018
59	1.0003	1.0004	1.0005	1.0006	1.0007	1.0008	1.0008	1.0009
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9997	0.9996	0.9995	0.9994	0.9993	0.9992	0.9992	0.9991
62	0.9993	0.9992	0.9990	0.9988	0.9986	0.9984	0.9983	0.9982
63	0.9990	0.9988	0.9985	0.9982	0.9979	0.9976	0.9975	0.9973
64	0.9986	0.9984	0.9980	0.9976	0.9972	0.9968	0.9966	0.9964
65	0.9983	0.9980	0.9975	0.9970	0.9965	0.9960	0.9958	0.9955
66	0.9979	0.9976	0.9970	0.9964	0.9958	0.9952	0.9949	0.9946
67	0.9976	0.9972	0.9965	0.9958	0.9951	0.9944	0.9941	0.9937
68	0.9972	0.9968	0.9960	0.9951	0.9944	0.9935	0.9932	0.9928
69	0.9969	0.9964	0.9955	0.9945	0.9936	0.9927	0.9924	0.9919
70	0.9965	0.9960	0.9950	0.9939	0.9929	0.9919	0.9915	0.9910
71	0.9962	0.9956	0.9945	0.9933	0.9922	0.9911	0.9907	0.9901
72	0.9958	0.9952	0.9940	0.9927	0.9915	0.9903	0.9898	0.9892
73	0.9955	0.9948	0.9935	0.9921	0.9908	0.9895	0.9890	0.9883
74	0.9951	0.9944	0.9930	0.9915	0.9901	0.9887	0.9881	0.9874
75	0.9948	0.9940	0.9925	0.9909	0.9894	0.9879	0.9873	0.9865
76	0.9944	0.9936	0.9920	0.9903	0.9887	0.9871	0.9864	0.9856
77	0.9941	0.9932	0.9916	0.9897	0.9880	0.9863	0.9856	0.9847
78	0.9937	0.9929	0.9911	0.9891	0.9873	0.9855	0.9847	0.9838
79	0.9934	0.9925	0.9906	0.9885	0.9866	0.9846	0.9839	0.9829
80	0.9930	0.9921	0.9901	0.9879	0.9859	0.9838	0.9830	0.9820
81	0.9927	0.9917	0.9896	0.9873	0.9851	0.9830	0.9822	0.9811
82	0.9923	0.9913	0.9891	0.9866	0.9844	0.9822	0.9813	0.9802
83	0.9920	0.9909	0.9886	0.9860	0.9837	0.9814	0.9805	0.9792
84	0.9916	0.9905	0.9881	0.9854	0.9830	0.9806	0.9798	0.9783
85	0.9913	0.9901	0.9876	0.9848	0.9823	0.9798	0.9788	0.9774
86	0.9909	0.9897	0.9871	0.9842	0.9816	0.9790	0.9779	0.9765
87	0.9906	0.9893	0.9866	0.9836	0.9809	0.9781	0.9771	0.9756
88	0.9902	0.9889	0.9861	0.9830	0.9802	0.9773	0.9762	0.9747
89	0.9899	0.9885	0.9856	0.9824	0.9795	0.9765	0.9753	0.9738
90	0.9896	0.9881	0.9851	0.9818	0.9787	0.9757	0.9745	0.9729
91	0.9892	0.9877	0.9846	0.9812	0.9780	0.9749	0.9736	0.9720
92	0.9889	0.9873	0.9841	0.9806	0.9773	0.9741	0.9728	0.9711
93	0.9885	0.9869	0.9836	0.9799	0.9766	0.9733	0.9719	0.9702
94	0.9882	0.9865	0.9831	0.9793	0.9759	0.9724	0.9711	0.9693
95	0.9878	0.9861	0.9826	0.9787	0.9752	0.9716	0.9702	0.9683
96	0.9875	0.9857	0.9821	0.9781	0.9745	0.9708	0.9694	0.9674
97	0.9871	0.9854	0.9816	0.9775	0.9738	0.9700	0.9685	0.9665

February Meeting: *Thursday, the 21st, Rio Hondo Country Club, Downey, Calif.*

Feature: *George A. Rutledge, The Bristol Co., will present a paper on "Measurement Applications of Electronic Potentiometers."*

Circle 57 on inquiry card. ⟶

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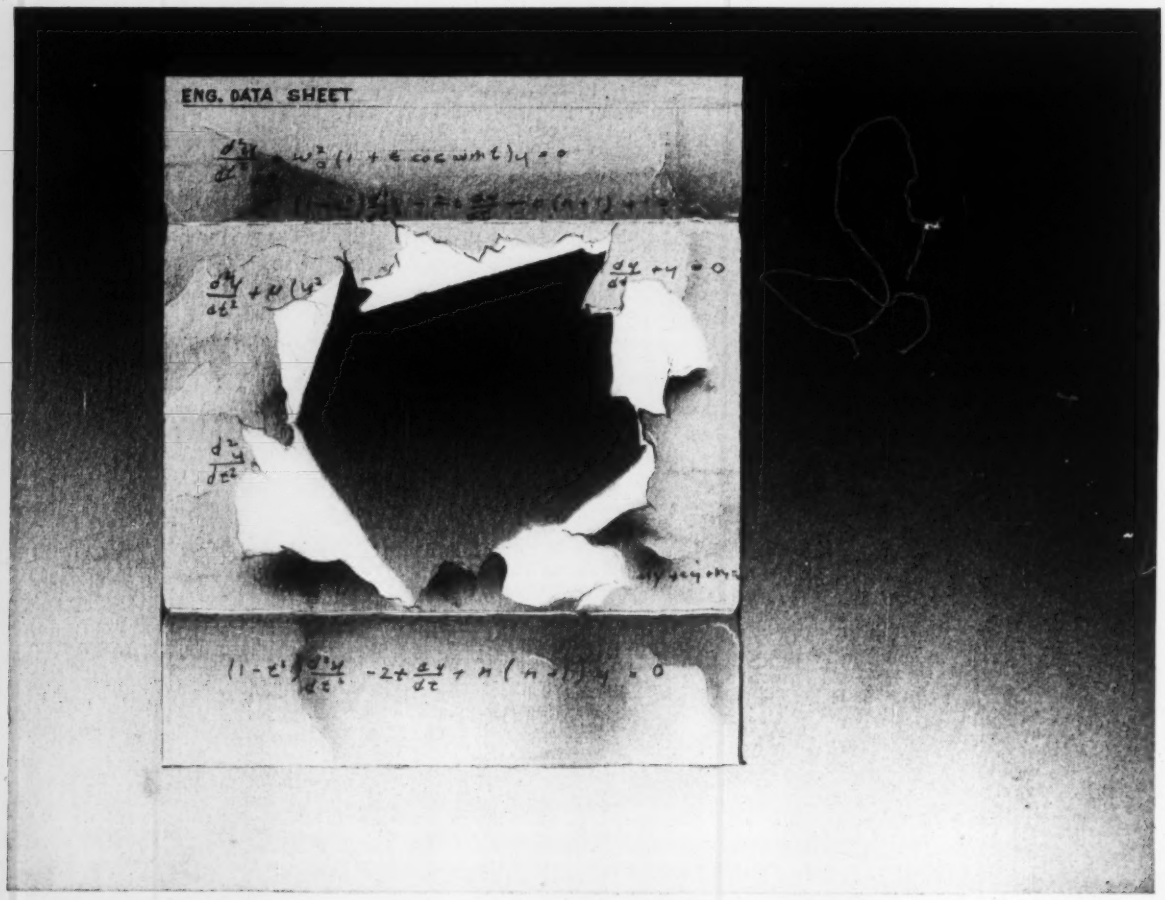
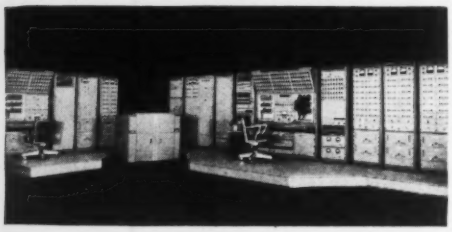


Break Through The PROBLEM Barrier



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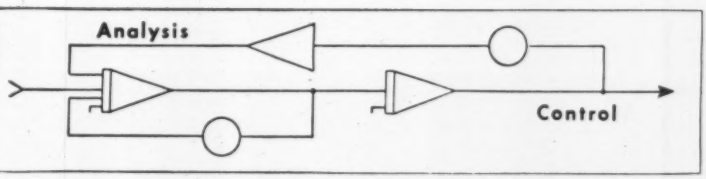

John H. McLeod, Jr., EDITOR

Suzette McLeod, SECRETARY

8484 LaJolla Shores Drive
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W. K. McGregor, ARO, Inc., Tullahoma, Tenn.; Chairman, Steering Committee.

Midwestern Simulation Council
A. C. Robinson, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio; Chairman, Steering Committee.

Canadian Simulation Council
F. W. Pruden, National Research Council, Ottawa; Chairman, Steering Committee

"The Objective of the Simulation Council is to improve the techniques and equipment for Simulation by improving communications at the working level."

The above objective of the original Western Simulation Council is quoted here because it was recently restated at the meeting of the Steering Committee of the International SC when representatives of all six Councils agreed that it is still valid. Perhaps it should appear somewhere at the beginning of each Newsletter so that all who read it will know what the heck we are trying to do. This sometimes helps!

Some further explanation might be in order however, as to what we mean by the "working level." We mean of course that the information should be exchanged among those who are most intimately concerned with the problem to be solved, but we also imply a time element; we wish to discuss problems and do what we can to coordinate attacks on them while they are still problems. *After* the problems have been solved, formal papers for presentation before technical societies are in order. That is not our province—by then we shall have done our work and turned to new problems.

Bits

This month—something different! Under "Pieces" Bernie Loveman as Secretary of the Eastern Simulation Council reports on "Simulation by Modeling and Analogies" as contrasted to our usual subject of Simulation by Electronic Differential Analyzers. As usual, Bernie (Reeves Instrument Corp., New York, N.Y.) has done such a good job on his notes that they are presented practically verbatim.

Through Bernie the Chairmen of the Eastern Simulation Council's Study Groups report their activities under "Information Without Theory."

Also under "Info" are the news of how the National SC became International, some comments on the International SC meeting which was held in conjunction with the Third International Automation Exposition, a mention of *Quasies and Peaks*, and the straight facts on a goof we made.

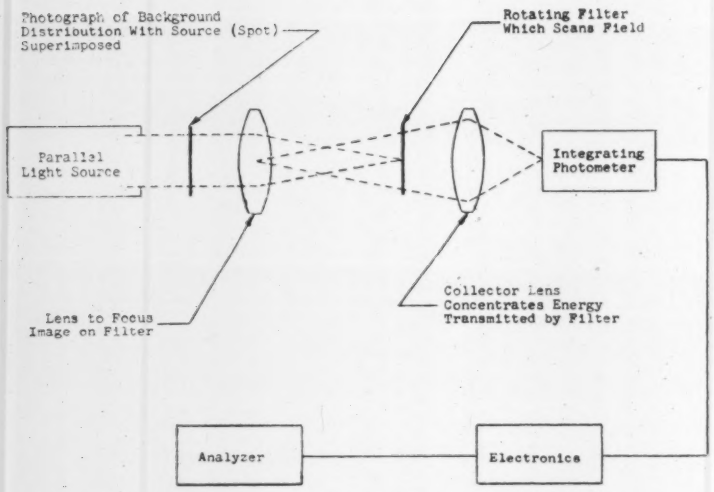
Pieces

"SIMULATION BY MODELING AND ANALOGIES"

Approximately 53 representatives of 31 organizations attended the September 24th meeting of the Eastern Simulation Council at Moore School of Electrical Engineering, University of Pennsylvania (Philadelphia). The host, Dr. Morris Rubinoff, arranged a tour of research activities at the Moore School. These included: (1) Automatic Electronic Telephone Switching Using Transistors (Project Daisy), explained by Professor L. Spandorfer; (2) Optical Radar Simulator, explained by T. Levine; (3) Synchrotron (Proton Accelerator) Design, described by Dr. P. Lombardini.

Irvine on Modeling

Norm Irvine (Mid-Century Instrumatic Corp. Los Angeles, Calif.)


Photograph of Background Distribution With Source (Spot) Superimposed
Rotating Filter Which Scans Field
Parallel Light Source
Integrating Photometer
Collector Lens Concentrates Energy Transmitted by Filter
Lens to Focus Image on Filter
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Electronics

Fig. 1. Optical simulator for detecting a source of radiation surrounded by a general background distribution.

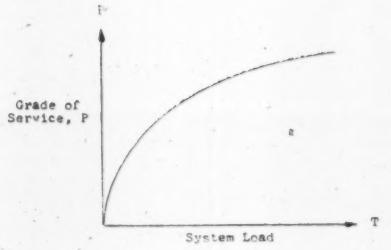

Fig. 2. Curve of telephone service vs system load, as determined by the Telephone Traffic Simulator.

opened the technical discussion at the meeting by describing three methods for simulation by modeling. These methods are:

1. Models which obey the same laws as the phenomena they describe —e.g., slide rules and network analyzers.

2. Mathematical models of physical or other phenomena—e.g., simulations solved on differential analyzers and high-speed computing machines.

3. Scaled models—e.g., airfoils in wind tunnels and equipment in test chambers.

Norm pointed out the similarity between the problem of space filtering and the more familiar electrical filtering. Space filtering includes the detection of geometric shape, color, intensity, and location. In both cases the problems are:

1. To design a method of searching for a given type of signal.

2. To reproduce a signal, with discrimination in favor of a desired signal and against others.

3. To improve a signal—i.e., to remove distortion.

The independent parameter for electrical signals is *time*, and for a space distribution it is *length*. The similarity between electronic filtering and space filtering extends to the use of Fourier transforms for both. However, the difficulty encountered in applying the mathematics of transform theory to optimize the design of an optical filter leads to the use of models.

Then Norm described the particular system of interest. The problem is to detect a source of radiation surrounded by a general background distribution. To do this the field is scanned with an appropriate optical filter system. A block diagram of the optical simulator is shown in Figure 1.

Weygandt on Traffic Simulation

The next speaker, *Professor C. Weygandt* (University of Pennsylvania) described a Telephone Traffic Simulator used to study a small telephone service having less than 100 subscribers. The problem, undertaken for the military, is to optimize the grade of service in emergency situations. The measure used for the grade of service is the probability, P, that when a call is attempted it will not be completed. Each party in the system has access to two lines.

The simulator consists of:

1. A board with pegs which represents the switchboard with its telephone jacks.

2. Checkers which represent the telephone plugs; when hung on the pegs they indicate plug connections to these lines.

3. Two sets of cards—(a) *White cards* specify the calls to be made; each card shows the caller, the telephone lines available to him, the receiver, his lines, and the length of the call. (b) *Pink cards* give the interval between calls (call interval).

The cards are made up from a table of random numbers and from assumed distributions for the call length and the call interval.

4. A rotatable time-sequence wheel holds the white cards in slots in the order in which calls are to be completed.

Each run consists of 100 cards and proceeds as follows:

1. The cards are shuffled.

2. The instructions on a white card are carried out—i.e., checkers are placed on appropriate pegs indicating which lines are in use.

3. The white card is inserted into the sequence wheel in a slot determined by the length of call—i.e., when the wheel has been rotated to this slot the time for this call has elapsed and the corresponding checkers are removed.

4. The pink card gives the time when the next call, white card, is to be tried.

As the run proceeds some of the calls will be blocked. White cards representing blocked calls are filed under two categories:

1. Receiver busy.

2. Receiver not busy (lines in use prevent completion of the call).

At the end of the run the grade of service, P, is determined by counting the total number of blocked calls.

The parameters in the study were the length of the call, its mean and distribution, the call interval, its mean and distribution, and the number of parties in the system. The load on the system, T, in call minutes per hour per party (i.e., number of minutes a party can expect to be on the line out of each hour) is given by

$$T = \frac{60}{1+(N/2)(\lambda/\mu)}$$

where $1/\lambda$ is call interval; $1/\mu$ is call length; N is number of parties in the system.

For each set of parameters ten runs were made and the mean and deviation of P were determined. A typical curve obtained during the course of this study is shown in Figure 2. The absence of electronic

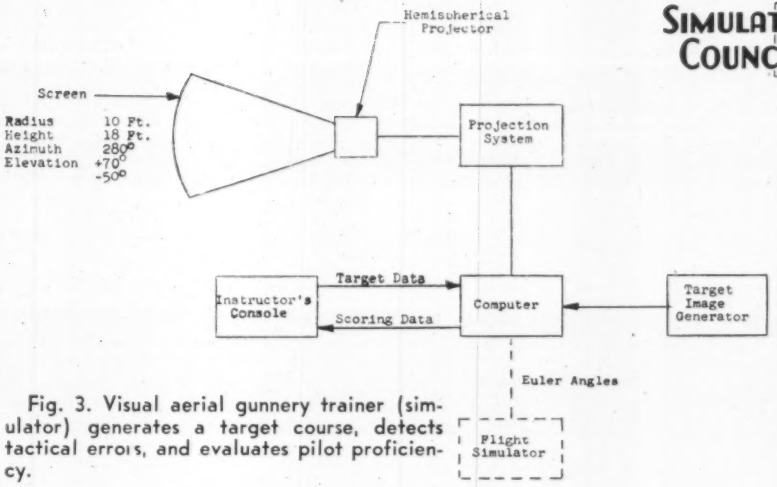

Fig. 3. Visual aerial gunnery trainer (simulator) generates a target course, detects tactical errors, and evaluates pilot proficiency.

devices and even electrical connections of any kind makes this simulator unique among those presented so far at Eastern Simulation Council meetings. Its simplicity makes it especially interesting.

Levine on Optical Radar Simulator

Ted Levine (University of Pennsylvania) was the third speaker, describing an Optical Radar Simulator constructed at the Moore School.*

The requirements for this simulator arose from the need to reduce the amount of computing equipment required to represent the motions of many targets. In this simulator, actual physical objects are moved; their motion is detected and presented on a radar screen. A plan position indicator (PPI) presentation is used.

The moving objects are small dc-motor-driven vehicles running on narrow-gage tracks located on the floor of a large room.** Each track is narrow enough so it can be bent to yield the desired trajectory. The tracks can also be moved to any desired location on the floor. Mounted on each vehicle is a light. An optical system is used to detect each target and these signals are converted to a PPI presentation.

The optical system, located in the center of the room at ceiling height, consists of a rotating multifaceted mirror, a reflector, and a photocell. The mirror rotates about a horizontal axis at high speed and scans a line across the floor. The target range is determined by the angular position of the mirror at which the target is detected by the photocell. The optical system is slowly rotated about a vertical axis scanning the entire floor once in each revolution. This rotation corresponds to the azimuth angle. Timing pulses for the PPI scope are determined by the motors used for the optical system.

Ted then described a proposed scheme to extend this technique to give three-dimensional targets—i.e., to add range-height indication (RHI). More complicated optical system and target vehicles would be required to obtain the desired signals.*

Loftus on a Gunnery Trainer

The final speaker, *Peter Loftus* (Rheem Manufacturing Company), used a model to describe a new visual aerial gunnery trainer. A block diagram of the system is shown in Figure 3, and a description of the trainer with photos appeared in *Aviation Week*, 27 August 1956, pp. 75-77.

Outstanding features of the trainer are:

1. Vidicon projection system with spherical screen surrounding cockpit.
2. Complete scoring system which evaluates pilot proficiency.
3. Detection and correction of errors in tactics from instructor's console.
4. Flexible target course generator.

*Probably the understatement of the meeting!—Ed.

*It is interesting to compare this system with the one Ted described at the National Simulation Conference in Dallas last January ("Optical Simulation of Radar," William Blitzstein and Theodore Levine, Proceeding, National Simulation Conference, 1956). From such changes progress is made.—Ed.

**Sounds like just the Christmas present Santa should bring the kids—for Pop!

Information (Without Theory)

We are now the *International* Simulation Council! Your Ed. had the pleasure* of being the guest of the National Research Council for their organizational meeting of the Canadian Simulation Council held on November 23rd in Ottawa.

About 30 representatives of 15 organizations attended this meeting and decided:

1. That there would be a Canadian SC.
2. That it would be organized (or disorganized) along the lines of the U. S. Councils.
3. That their activities would be published in this Newsletter.
4. That Fred Pruden (National Research Council, Ottawa) would be first Chairman of the Steering Committee.

So as might have been hoped and expected, our friends to the North are the first outside of the United States to join us. We hear that an analog computation center is to be established by one of our most ardent supporters in this country. Would not a European SC then be in order?

*And I do mean pleasure! Suzy and I were wined and dined by Fred Pruden and the Glinskis in a most sumptuous manner.

* * *

First Int'l S/C Meeting

The Second Annual National (or First Annual International) Simulation Council Meeting in New York City, 28-29 November 1956, consisted of four discussion sessions typical of those held throughout the country by the various individual Councils, plus a high-ball party similar to the one in Dallas last January, and a meeting of the Steering Committee of the International Simulation Council. The discussions will be reported in the next and possibly subsequent Newsletters.

The Steering Committee discussed finances, methods of publishing the *Newsletter*, plans for future Interna-

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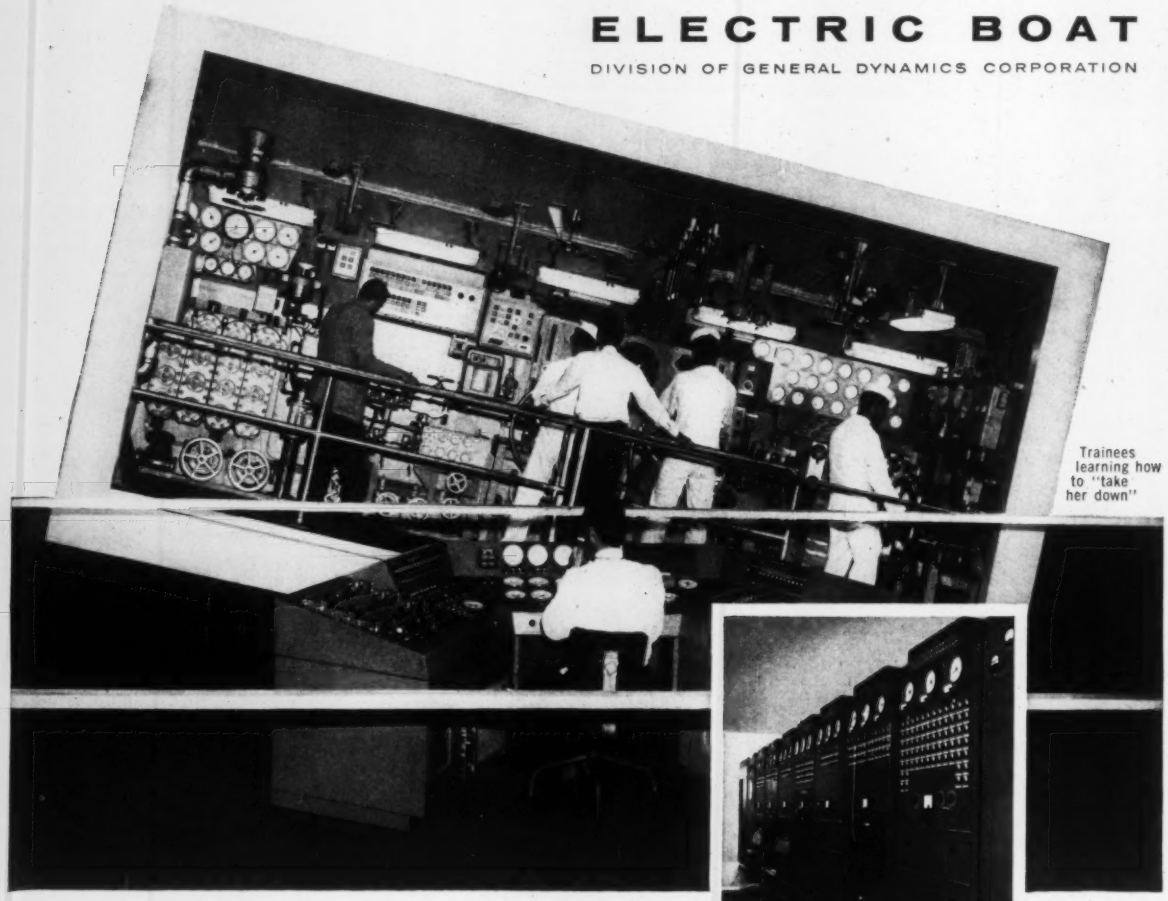

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tional meetings, and elected Dr. Robert M. Howe, Department of Aeronautical Engineering, University of Michigan, to succeed your Editor as Chairman of the ISC's Steering Committee. Congratulations, Bob. I know you will enjoy working with representatives of the six Councils as much as I have.

* * *

Study Group Report

Five Eastern Simulation Council Study Groups met during lunch on September 24th. Bernie Loveman (Secretary of the ESC) and the chairmen of the various groups reports their discussions below:*

Fourteen members representing 11 organizations attended the *Physical Simulation Group (H. Wexler)*. The use and versatility of flight tables were discussed. Accuracy and checking of simulated systems that include hardware were also considered.

Six members representing five organizations attended the *Operations Research Group (A. S. Jackson)*. Definitions of Operations Research and its scope were reviewed. Solution of linear and nonlinear programming problems using analog computers was discussed.

Nineteen members representing 13 organizations attended the *Dead Time Simulation Group (B. Loveman)*. Definitions for time delay and criteria for evaluating delays were presented. The latter included frequency response and time domain methods. A bibliography on simulation of time delays was reviewed.

Six members representing as many organizations attended the *Transfer Function Group (H. Mori)*. Among the subjects discussed were: (1) Magnetic computing amplifiers; (2) Transistors for dc amplifiers; and (3) Plug-in versus patched R-C networks.

* * *

About that goof, mentioned in Bits. We have several times been credited with having a crystal ball and using it to good effect. Not so in last September's issue, however. In a writeup of the Midwestern SC's July meeting we attributed a remark to Elliott Buell, who wasn't even at the meeting, instead of to George Goelz, who was. (One thing the two men do have in common, though; they both work at the Aerial Measurements Laboratory, Northwestern University.) According to the *Newsletter* writeup Elliott asked "whether anyone had made a study of the accuracy of the direction-cosine technique using resolvers. He wanted to know which method is superior with respect to equipment and cost." Actually George Goelz asked, "Has anyone ever made a comparison of the relative accuracies and equipment economies of the direction-cosine technique versus the Euler-angle method?". George addressed a second question to Don Kowalski: "Since the flight table is a velocity servo device, what about eventual angular errors in resolving due to instantaneous mismatching of table rates and command rates?"

*The names of the group chairmen appear in parentheses.

Interference!

We received a newsletter called *Quasies and Peaks* with a covering letter from Rexford Daniels, President of Interference Testing and Research Laboratory, Inc. (150 Causeway Street, Boston 14, Mass.) which says in part: "We try to find out what is going on in the interference (noise) field and pass it on . . . The field of interference suppression is expanding so rapidly that it is very hard to keep up with what is going on. Hence we are attempting to coordinate the various interests in the field until some other group decides to take it over."

Now those of you with noise problems have someone to commiserate with.*

*We're ending the Newsletter with a preposition just to show the people who say you can't do that sort of thing that we can!

Computer Events

Other events on page 21

Eastern Simulation Council

Date: 28 January 1957

Place: Applied Physics Laboratory, Johns Hopkins University, Howard County Building. Transportation will be provided from 8621 Georgia Avenue, Silver Spring, Maryland.

Subject: "Resolvers"

Times: 10:00—Steering Committee
11:30—Technical Session
1:30—Lunch and Study Groups
3:00—Technical Session

International Business Machines Corp. and New York University Symposium

Dates: 30 January—1 February

Place: New York, N. Y.

Subject: "Digital Computing in the Aircraft Industry"

Southeastern Simulation Council

Date: 15 February 1957

Place: N. C. State College, Raleigh, N. C.

Program: 9:00 A.M.—12:00 P.M. Papers and discussion on general theme of solution of mathematical problems on analog and digital computers with special emphasis on the use of analog equipment. Talks by Mr. P. J. Hermann, Aerophysics Department, Goodyear Corporation; Mr. Donald Byck, Princeton Computation Center, Electronic Associates; and Dr. E. H. Tompkins, Jr., of the Engineering Research Department, North Carolina State College.

12:30 P.M.—Dutch Luncheon

2:00 P.M.—5:00 P.M.—Tour of facilities and further discussion.

1. GEDA—Goodyear electronic differential analyzer.
2. IBM 650 digital computer
3. Nuclear reactor
4. Granpa—Graphical and Numerical Photoelectronic Analyzer (a computer under development for making a statistical analysis of graphically recorded data.)

6:30 P.M.—Dutch Dinner—Talk by Dean J. H. Lampe on Education for Superior Students.

Western Joint Computer Conference

Dates: 26-28 February 1957

Place: Hotel Statler, Los Angeles, California

Subject: "Techniques for Reliability"

Third Annual High-Speed Computer Conference

Dates: 5-8 March

Place: Louisiana State University, Baton Rouge, La.

Midwestern Simulation Council

Place: Houston, Texas
This meeting will be held in conjunction with the Southwestern IRE Conference and Exhibit at the Shamrock Hilton Hotel April 11, 12, and 13.

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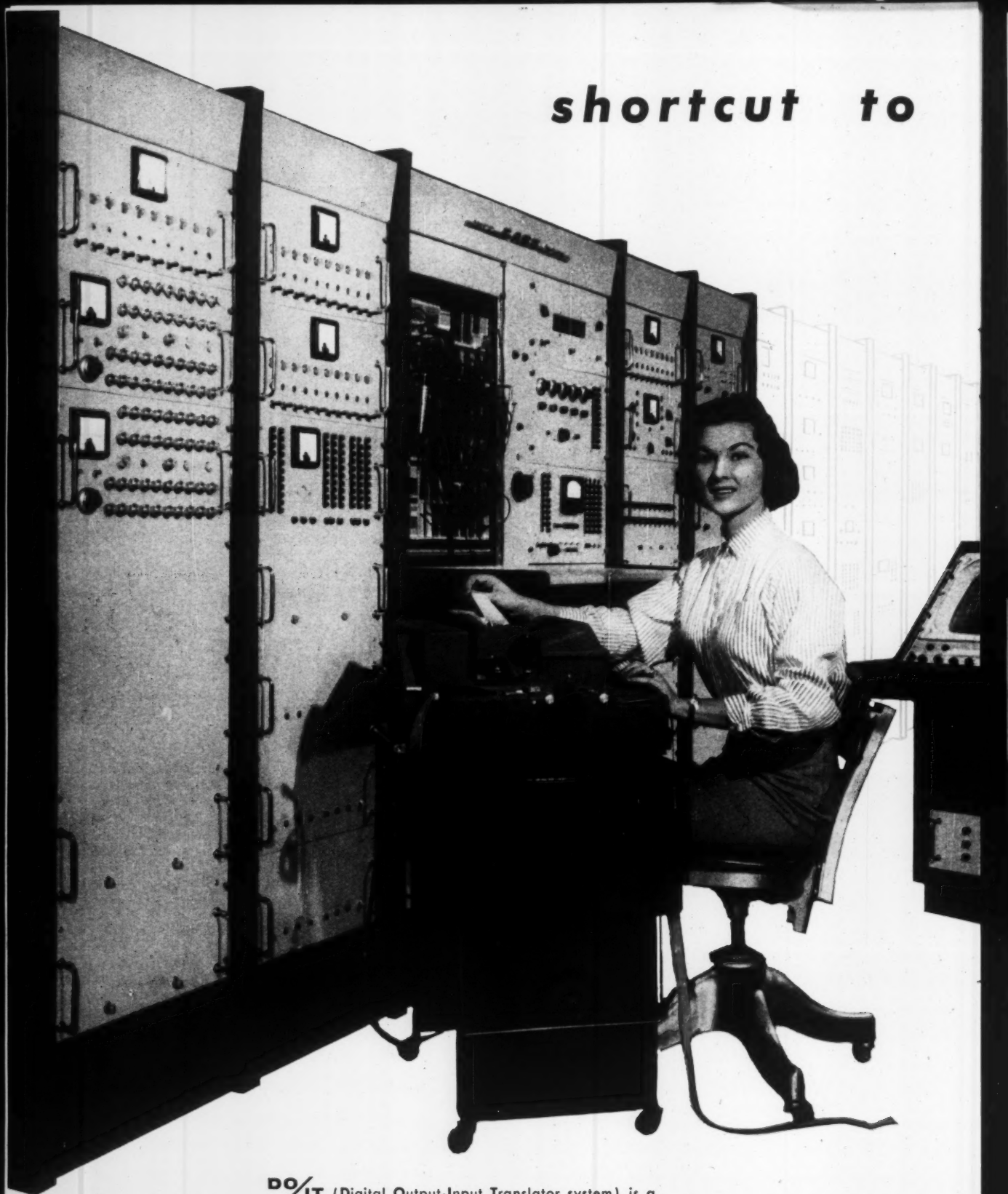

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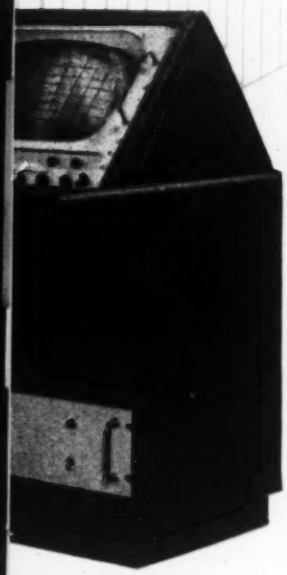

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FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 177

PROCESS MEASUREMENT and CONTROL

DIGITAL INDICATOR

New "Model 756" features slide-out chassis; requires minimal panel space (7" x 7"); accepts signals from various primary elements; incorporates

a null-balance servo system. Nonlinear inputs are linearized by means of a tapped slidewire; therefore a shaft-position encoder will provide an output which can be fed directly into printout equipment.—*Performance Measurements Co.*, 15301 *W. McNichols Rd., Detroit* 35, *Mich.*

For more information circle **201** on inquiry card.

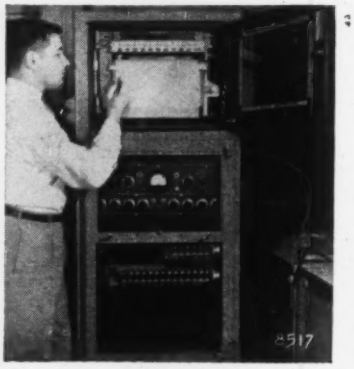
PROCESS CHROMATOGRAPH

New "Type 26-202" automatic vapor-phase chromatograph (supplementing lab type "26-201") is designed for use in hazardous areas, comprises: (1) analyzer for use at sample point in hazardous location, and (2) control unit which can be located as much as 500 feet away. It makes use of elution method of vapor-phase chromatography. A fixed sample of gas is introduced into a carrier-gas stream (e.g. helium, hydrogen, nitrogen), and washed down through a chromatograph column by continuous flow of carrier gas. Because components in sample will travel through column packing at a rate dependent on individual physical properties, each component will emerge from bottom of column at a different time. As each component emerges, its concentration in carrier stream is measured by a thermal conductivity cell and is indicated on a recorder as a peak. Superior reproducibility stems from precise regulation of operating parameters: sampling valve introduces sample volumes reproducible to better than 0.5%; sample and column temperatures are controlled to 0.5C°; carrier gas flow-rate variations are held to 0.1%, voltage to thermal conductivity cell is regulated to better than 0.5%.—*Consolidated Electrodynamics Cor.*, 300 *North Sierra Madre Villa, Pasadena, Calif.*

For more information circle **202** on inquiry card.

PROCESS CHROMATOGRAPH

New Process Gas Chromatograph analyzes industrial gases by directly sampling a process stream. Samples are passed through a chromatographic column of absorbent material (not shown) which breaks them up into their component parts. A stream of helium from cylinder at right washes fractions out of column, in successive order, and then through a thermal conductivity cell which determines both amount and type of compounds present. This information is presented as a "bar graph" on recorder chart. Precisely-timed sampling valves (below front) can be set to analyze up to eight components of a single plant stream, or from two to seven different plant streams of similar composition. Once set, instrument's operation is completely automatic.—*Beckman Instruments, Inc.*, 2500 *Fullerton Rd., Fullerton, Calif.*

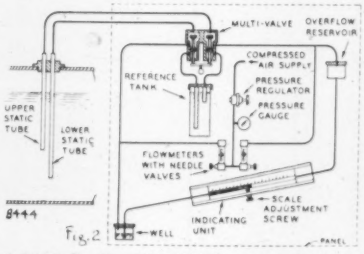


For more information circle **203** on inquiry card.

SPECIFIC GRAVITY INDICATOR

New "No. 1561" remote-reading liquid specific gravity indicator, said to have "many installation, operation

and maintenance advantages," is fully automatic; features accuracy of 0.001 Sp.G. unit, with interpolation to

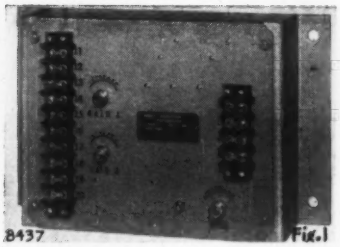


0.0005 Sp.G. unit. All functional parts are conveniently mounted on rear of panel. Adjustments are made from front of panel. Parts are accessible by swinging open hinged panel door. If desired, entire front panel can be removed from cabinet by a quarter-turn of four quick-lock fasteners.—*Petrometer Corp.*, 43-22 *Tenth St., Long Island City* 1, *N. Y.*

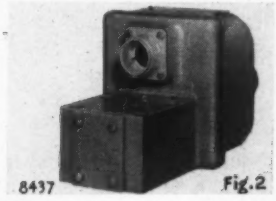
For more information circle **204** on inquiry card.

ELECTROHYDRAULIC MACHINE CONTROLS

New "XRJ301A" transistorized servo amplifier (Fig. 1) and new "XVJ300A" electro-hydraulic servo valve (Fig. 2) for electrohydraulic control of industrial machinery are "building-block" components said to "combine the best features of electronic signal sensing with hydraulic control of variable-delivery pumps, hydraulic motors, cylinders, and simi-



lar equipment" and to "make it practical to apply hydraulic power to many applications previously limited

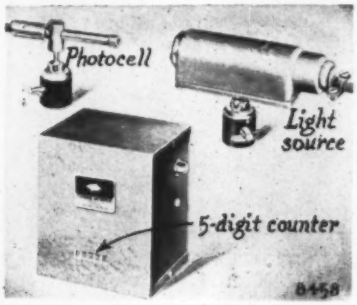


to electric drives. They also provide precision control of existing hydraulic equipment which could not previously be controlled automatically." —*Machine Controls Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

For more information circle **205** on inquiry card.

PHOTOELECTRIC CONTROLS

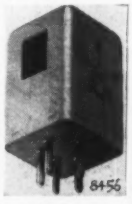
New "Model REC Robot Eye" photoelectric control systems feature miniaturization (photocell ⅜" O.D.).



Both light source and cadmium sulfide photocell are swivel-mounted for ease of installation and alignment. Sensitivity is widely adjustable. Speed limit 600 counts per minute.— *Standard Instrument Corp., 657 Broadway, New York 12, N. Y.*

For more information circle **206** on inquiry card.

PHOTOELECTRIC CONTROL



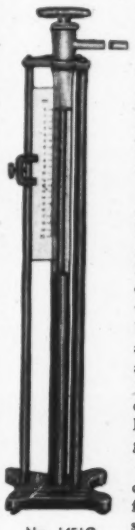
New "Model 1 CDS Photorelay" comprises a broad-area cadmium sulfide photocell and maker's "Series 41" relay, mounted on a 5-pin plug-in base and housed in a dust can 1½" square x 2¼" high. It operates at five foot-candles or less, releases at 0.1 f-c or more, at a guaranteed speed of two operations per second. Supply

WELCH

DUBROVIN VACUUM GAUGES

Compact Practical Gauges For Moderately Reduced Pressures

- Range: 0.2 mm To 20 mm of Hg
- Two Sensitivities Available
- Far More Sensitive Than Mercury Manometer
- Pyrex-Brand or Soft-Glass Construction
- Table or Wall Mounting



No. 1451C. Table Mounting

The Dubrovin Gauge indicates the pressure continuously, may be left in the system indefinitely, and is not damaged if the line is suddenly opened to atmospheric pressure. It is simple to install and convenient to use. A typical application for which it has proved especially convenient is the filling of tubes with gas at a specified pressure, as in the luminous-tube industry. It is useful wherever a sensitive gauge of this range is needed.

There are two basic types, one 9 times and the other 6 times as sensitive as a mercury manometer. Because of this "magnifying factor", the gauge is as sensitive as a manometer which uses a liquid of low density, but has the advantage of using mercury which dissolves very few organic or inorganic vapors and which requires no conversion factor. Unlike mechanical or optical magnifying devices, any small errors due to capillarity, adhesion, etc., are not magnified. The smallest division on the 9-to-1 type is 0.2 mm and on the 6-to-1 type is 0.5 mm of Hg. Fractions of these values may be estimated. Both types are available with Pyrex-brand or soft glass in either a table or wall mounting.

The Dubrovin Gauge consists of a stainless-steel cylinder, of small diameter and closed at one end, floating vertically in mercury with its open end submerged and with the air evacuated from the chamber thus formed. The outer tube, in which the cylinder and mercury are enclosed, is of glass mounted in a metal frame and connected to the vacuum line. An adjustable scale on the metal frame is read by an indicator at the top end of the floating cylinder.

No. 1451H. Wall Mounting

The action of the Dubrovin Gauge may be explained as follows. When both the float chamber and gauge chamber have been evacuated, the buoyant force acting on the float (the weight of mercury displayed by its submerged walls) is in equilibrium with the weight of the float. Under these conditions the float is in its highest position. When the pressure in the outer chamber increases it exerts a downward force on the float, causing it to sink until the additional mercury displaced is sufficient to compensate for the downward force and again produce equilibrium. The magnification factor is a function of the dimensions of the float.

Cat. No.	Pressure Range mm of Hg	Magnifying Factor	Merc. Req'd. Lbs.	Material of outer tube	Mounting	Each
1451C	0.50 to 20	6	1	soft glass	Table	$47.50
1451D	" " "	"	"	Pyrex Brand	"	47.50
1451G	" " "	"	"	soft glass	Wall	47.50
1451H	" " "	"	"	Pyrex Brand	"	47.50
1451E	0.2 " "	9	2¼	soft glass	Table	55.00
1451F	" " "	"	"	Pyrex Brand	"	55.00
1451J	" " "	"	"	soft glass	Wall	55.00
1451K	" " "	"	"	Pyrex Brand	"	55.00

NOTE: The use of C.P. mercury is essential for the proper operation of Dubrovin Gauges.

W. M. WELCH SCIENTIFIC COMPANY
DIVISION OF W M WELCH MANUFACTURING COMPANY
ESTABLISHED 1880
1515 Sedgwick Street, Dept. B, Chicago 10, Illinois, U.S.A.
Manufacturers of Scientific Instruments and Laboratory Apparatus

For more information circle **61** on inquiry card.

KIRKLAND

ANNUNCIATOR COMPONENTS

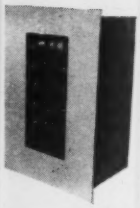
FOR MODERN SERVICE ON EXISTING PANELS

• INVESTIGATE • TYPE RBE UNIT

LAMP AND RELAY ASSEMBLY.

The RBE unit is a one lamp annunciator with up to three relays, (3PDT) in an anti-dust can. Pre-wired. No external cabinet. Mount one or many in 1⅜" dia. Holes on 2½" centers. All modern services. Single-hole mounted. Any length cable with variety of plug-in connectors. Other Kirkland components make annunciator construction simple. Write for full catalog, N O W.

KIRKLAND ANNUNCIATORS



TYPE ML LOWEST IN COST

Illuminated message with up to three bulbs per section. Each section, 3¾" x 1½". With or without individual switch. All modern alarm services, plus customer specification. Any number sections per cabinet. Hundreds of ML systems in use. Economical.

CUSTOM-MADE WITH STANDARD PARTS

TYPE GR ANNUNCIATOR

Kirkland annunciators are in service in many prominent utility and industrial plants.

Established 1930

THE H. R. KIRKLAND CO.

Morristown, N. J.

For more information circle **62** on inquiry card.

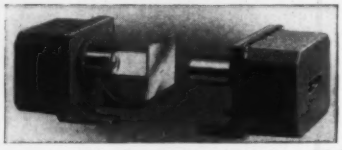
NEW INSTRUMENTS

voltage 115 vac 50/60 cps; temperature range −40°C to 75°C.—*Sigma Instruments, Inc., 59 Pearl St., South Braintree, Boston 85, Mass.*

For more information circle **207** on inquiry card.

GLASS-OPERATED PHOTOELECTRIC CONTROL

New photoelectric control is for operation by glass, cellulose and other transparent materials. Its new light

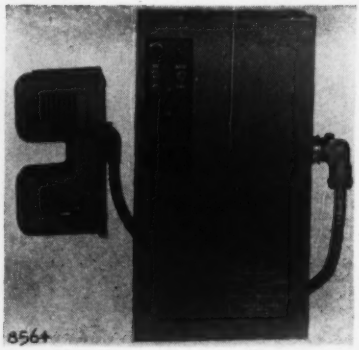


source emits short wave-lengths which glass interrupts. Its new phototube is actuated by this ultraviolet beam. Minimum phototube light time and dark time 0.05 sec. Control relay energizes when light is on phototube. Contacts are dpdt, rated 8 amp 115 vac non-inductive.—*Autotron, Inc., Box 722-CC, Danville, Ill.*

For more information circle **208** on inquiry card.

EDGE CONTROL SYSTEM

New "Linar Edgetrol Photoelectronic Edge Guidance System" is self-contained and fully automatic. Choice of



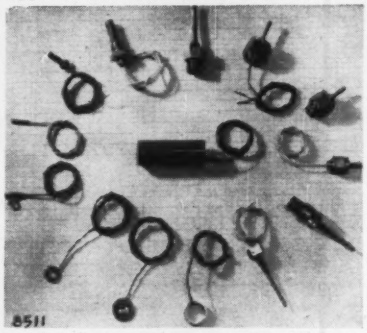
seven sensing heads enables complete system operation with any material under any conditions. New system successfully controls edge registration and web position to 1/32" at any speed.—*Intercontinental Dynamics Corp., 170 Coolidge Ave., Englewood, N. J.*

For more information circle **209** on inquiry card.

TEMPERATURE

RESISTANCE-THERMOMETRIC PRIMARY ELEMENTS

New resistance-type temperature probes, for telemetering and other applications requiring high signal



levels, give outputs up to 5 v without amplification. Models are available for air, liquid and surface temperatures, from −320°F to 500°F (specials to 1600°F); can be used in ac or dc bridge circuits. Each is supplied with serialized calibration curve.—*Arnoux Corp., 11924 West Washington Blvd., Los Angeles 66, Calif.*

For more information circle **210** on inquiry card.

RESISTANCE-THERMOMETRIC INDICATORS & CONTROLLERS

New resistance-type instruments permit small scale spans (as short as 50 F°), hence more accurate readings, especially at room to sub-zero temperatures. Resistance bulb can be

up to 1000 ft. from instrument and calibration need not be changed with lead-length. New line includes single- and multi-point indicators and controllers having many control functions.—*West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.*

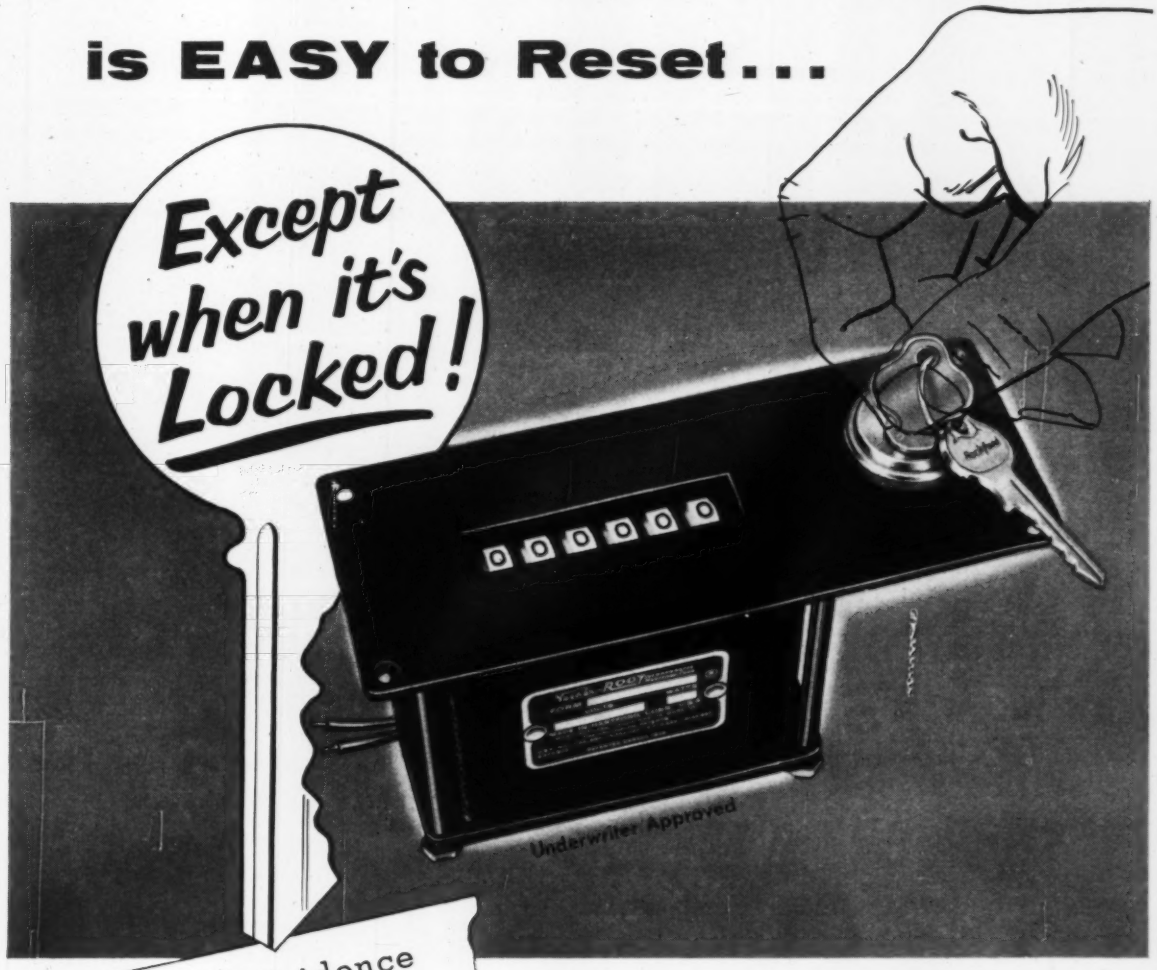
For more information circle **211** on inquiry card.

TEMPERATURE CONTROLLER

New model of "Simplytrol" combines extreme sensitivity of a thermistor bridge circuit with dual indicat-

This NEW Magnetic Counter

is EASY to Reset...



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

Designed for panel mounting where remote indication is required, this electrically operated counter is a compact package 5.5″ long, 2.1″ wide, 2.7″ high. Capacity: 1,000 counts per minute. Power consumption, 8 watts. Stocked in 110 and 220 AC and DC. Easy to reset, except when locked . . . then the sturdy tumbler-lock* puts the damper on tampering. Yet one turn of the key resets all 6 figures to zeros.

This new Magnetic Counter is one of the thousands of Veeder-Root standard and special counters . . . electrically, mechanically and manually operated . . . in daily use throughout the world in industry, business, science and medicine. You, too, can count on Veeder-Root . . . to help you count anything you need.

*National Lock Co. Lock No. 68-4837, Key D-428

Stocked at
Hartford 2, Conn. • New York 19, N. Y.
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VEEDER-ROOT
"THE NAME THAT COUNTS"

For more information circle **63** on inquiry card.

The
Curtiss-Wright
"SNAPPER"

NEW CONCEPT... ADVANCED DESIGN IN THERMAL TIME DELAY RELAYS

- Eliminates chatter with **snap action**
- Single-pole, double throw contacts
- Wide ambient range (−65°C +100°C)
- For military, commercial and industrial applications
- Metal envelope (7 or 9 pin) miniature or (8 pin) octal
- Glass envelope in 9 pin miniature
- Preset time delays in metal from 3 to 90 seconds, glass from 5 to 60 seconds

Write to Thermal Devices Department for latest data sheets

ELECTRONICS DIVISION
CURTISS-WRIGHT
CORPORATION • CARLSTADT, N. J.

Curtiss-Wright has career positions open for qualified engineers and technicians.

For more information circle **64** on inquiry card.

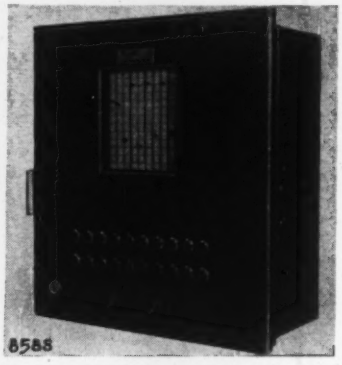
NEW INSTRUMENTS

ing and controlling function of a contact-making instrument; acts upon a temperature change as small as 0.075F°. Thermistor can be located as far as 200 ft from controller without affecting indicating or controlling accuracy. No intermediate amplifier is required. Models available in a number of temperature ranges, beginning with a minimum span of 15F° for full scale of 95 angular degrees. Practical range limits −75°C to 300°C (−103°F to 572°F). Either automatic on-off or locking limit control action is available.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **212** on inquiry card.

MULTI-POINT AUTOMATIC TEMPERATURE CONTROLLER

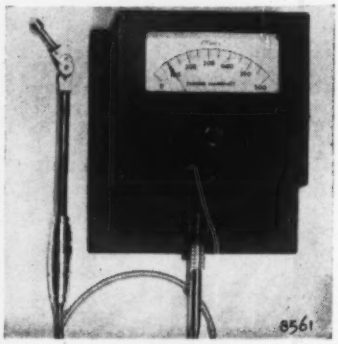
New "Multi-Point Pyrometer Controller" controls 4 to 10 units; combines accuracy of null-balance potentiometer measuring circuit with speed of electronic control system; is applicable to almost any installation suitable for two-position control action. Many temperature ranges are available between −400°F and 3250°F for all standard thermocouple calibrations and from −100°F to 1600°F for resistance bulbs.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*



For more information circle **213** on inquiry card.

PYROMETER FOR SURFACE TEMPERATURES

New "Type R-4200" wall-mounted pyrometer with flexible arm combines convenience of a portable and instrument protection of a wall-mounted unit; enables a manufacturer with a battery of ovens, platens, molds, etc., to locate a surface instrument permanently at each station for production checking of surface temperatures. Choice of ten thermocouples.—*Illinois Testing Laboratories, Inc., 420 No. LaSalle St., Chicago 10, Ill.*



For more information circle **214** on inquiry card.

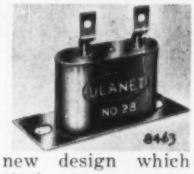
TEMPERATURE CONTROLLERS

Two new dual-range models are added to maker's "Series 560" line of thermistor-actuated temperature controllers. Operating ranges of "Model 56006" are 200-600°F and 100-300°F, providing a total coverage from 100°F to 600°F. "Model 56007": −100 to +50°F and 0-150°F, total spread −100 to +150. Choice of two control modes: on-off, or time-modulated proportioning. Choice of various encased or bare thermistor primary elements.—*Fenwal Inc., Ashland, Mass.*

For more information circle **215** on inquiry card.

SURFACE-TEMPERATURE-TYPE THERMOSTAT

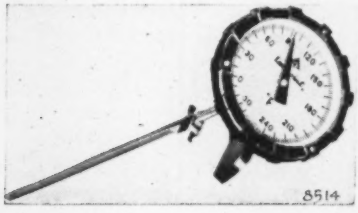
New hermetically sealed surface-sensing miniature thermostat, first of its kind available to industry in quantities, features new design which shortens heat path between mounting surface and thermal-sensing element. Units are factory set and adjustment screw is sealed. Mounting holes 1" centers.—*George Ulanet Co., 425 Market St., Newark 6, N. J.*



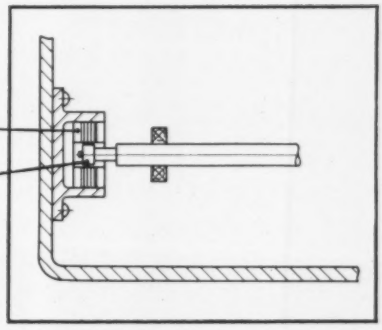
For more information circle **216** on inquiry card.

DIAL THERMOMETER

New "Tempoint" multi-purpose dial thermometer with −40°F to 240°F range is suited for both indoor and



Now... The TACHOMETER GENERATOR can be "built-in"

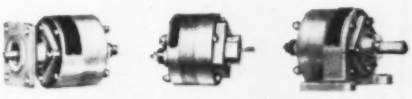


Weston bearingless tachometer generator mounted inside equipment housing. Where external mounting is required, however, pad type projects only 2½".

WESTON Bearingless Tachometers save Space...Weight...Cost!

With the Weston bearingless design, the tachometer generator can now be built-in, rather than attached to, rotary equipment. But where external mounting is essential, the special pad housing projects only 2½". Either way, it means big *weight saving* and *space saving;* and lends itself to better overall design. Best of all, the compact rotor and stator are oil-resistant and virtually trouble-free ... and initial costs are now 'way down. Can be used with individual or duplicate and remote indicators, and with Weston recorders. Speed ranges, low as 500 and up to 80,000 rpm full scale. For the complete Weston Tachometer story, send for catalog to-day. *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N.J.* A subsidiary of Daystrom, Incorporated.

Weston Indicators are available in required sizes and shapes, calibrated in any function of RPM.



Weston A-C and D-C Generators available in all external mounting types including explosion proof and heavy duty.

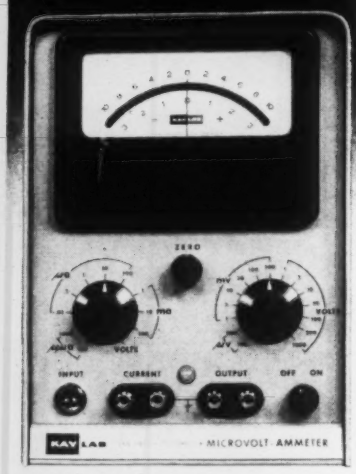
WESTON TACHOMETERS

For more information circle **65** on inquiry card.

SUCCESSOR TO VTVM

measure amplify

μv...mua



Universal DC Meter

This new microvolt-ammeter-amplifier will measure as little as 10 μv or 10 μμa with accuracy. It may also be used as a DC amplifier with up to 80 db gain and only 10 μv drift. A zero-center mirrored scale provides instant polarity indication. Utilization of Kay Lab's chopper stabilized circuit provides versatility, accuracy, and stability that is unobtainable with conventional VTVM's. The Model 203 is the ideal general purpose laboratory meter, production test set, or null meter.

SPECIFICATIONS

- 100 μv to 1000 v fs
- 100 μμa to 100 ma fs
- 25 ranges
- 100 megohms input
- 80 db gain as amplifier
- 10 μv equivalent input drift
- 1 volt output
- Price $550.

Representatives in all major cities
Write for literature or demonstration

KAY LAB

5725 KEARNY VILLA ROAD
SAN DIEGO 11, CALIFORNIA

For more information circle **66** on inquiry card.

NEW INSTRUMENTS

outdoor use. (For measuring warm-air plenum and cold-air return temperatures simultaneously as required for continuous air circulation adjustment, maker offers a kit of two in a neat carrying case.) Among features: 2½" aluminum dial with easy-to-read black numerals and red indicating pointer; 9" stainless steel stem; holding sleeve adjustable on stem.—*Bacharach Industrial Instrument Co., 200 N. Braddock Ave., Pittsburgh 8, Pa.*

For more information circle **217** on inquiry card.

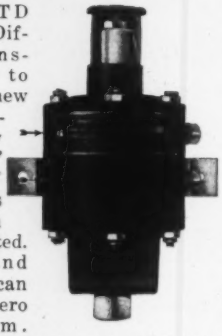
INDUSTRIAL THERMOSTAT

New general-purpose industrial thermostat with dp-st ac switch (dc on special order) is designed for such applications as sterilizers, water and oil heating, degreasing tanks, melting pots, etc. Copper bulbs and capillaries are supplied for applications up to 250°F, and steel bulbs and capillaries for use up to 700°F. Standard bulb diameters are ⅜" and ⅝"; capillary lengths available up to 180". —*General Electric Co., Schenectady 5, N. Y.*

For more information circle **218** on inquiry card.

FLOW-RATE, VOLUME, LEVEL, WEIGHING

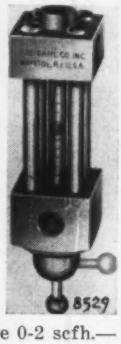
FLOW-RATE TRANSMITTER



New "200TD Fixed Range Differential Transmitter," said to "introduce a new concept in low-cost flow transmission," measures 6½" x 3"; weighs 4½ lbs; can be pipe-mounted. A wrench and screw driver can install and zero it on stream. Maximum working pressure 150 psi; temperature 150°F; air supply pressure 20 psi; air consumption 0.1 scfm; output pressure range 3 to 15 psi; calibration accuracy better than 1%; sensitivity better than 0.1%. Ranges 0 to 50, 100, 200 and 300 inches of water. Indoor or outdoor mounting.—*Taylor Instrument Companies, Rochester 1, N. Y.*

For more information circle **219** on inquiry card.

SIGHT FLOW INDICATOR

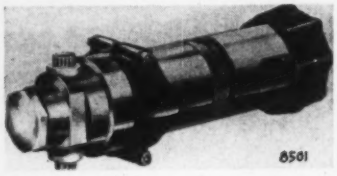


New Sight Flow Indicator is a combination header and "Demi" toggle valve for tight shut-off; indicates leakage flows, or any small flow which requires checking. Since "Demi" valve toggles shut in one plane, open or closed position is positively indicated by a distinctively colored ball. A design variation is used on purge systems, with a minute 200-to-1 rangeability needle valve for throttling. Flow range 0-2 scfh.—*George W. Dahl Company, Bristol, R. I.*

For more information circle **220** on inquiry card.

FLOW REGULATOR

New 6000-psi unit is said to be "the widest range high-flow regulator yet developed." Burst maximum 15,000 psi; maximum required handle torque 30 lb-in; adaptable for use with air,



nitrogen, helium, and gaseous oxygen; choice of ¼" tube or ¼" pipe thread; internal 5-micron filter; bubble-tight shut-off.—*Accessory Products Corp., Dept. IA, 616 W. Whittier Blvd., Whittier, Calif.*

For more information circle **221** on inquiry card.

CHEMICAL PUMP

New pump, available in capacities to 5 gpm with pressures to 50 psi, has both body block and liner made

of fluorocarbon materials which resist most corrosives at temperatures up to 300°F. Fluids or slurries are isolated in passage formed by outer surface of Kel-F liner and inner surface of Teflon or Kel-F body block.—*Vanton Pump & Equipment Corp., 201 Sweetland Ave., Hillside, N. J.*

For more information circle **222** on inquiry card.

LIQUID LEVEL CONTROLLER

New "Auto-Level," said to be "ideal for applications where physical contact with the material being measured is undesirable," utilizes changes in differential air pressure to indicate and control level. Variation of back pressure in sensing tube is magnified by a differential pressure controller with an amplifying stage. A

The 20th Century's most challenging opportunity for the creative engineer...

Automatic Control Systems

for tomorrow's needs and hypersonic speeds

Ten years ago—when AUTONETICS began its work—miles-per-hour thinking had to be abandoned. The task of developing guidance and control systems for the Air Force SM-64 NAVAHO Intercontinental Missile demanded engineers who could design, manufacture, test and *produce in quantity* automatic controls that would operate in environments and at speeds never before experienced.

Today—because of its proved ability to convert ideas into engineering fact—AUTONETICS is one of the few organizations in the world with a unique stockpile of experience in information processing, inertial navigation, flight controls, armament control systems, computers and other automatic control systems.

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The projects we are pursuing at AUTONETICS call for extremes in mindpower and environmental facilities.

We have the facilities... among them a new Autonavigation building where each cubic inch of air contains fewer than 6 dust particles... where temperature variation is held to plus or minus 1°.

And we have a Flight Test Section second to none.

The mindpower—frankly, we'd like to find more of it.

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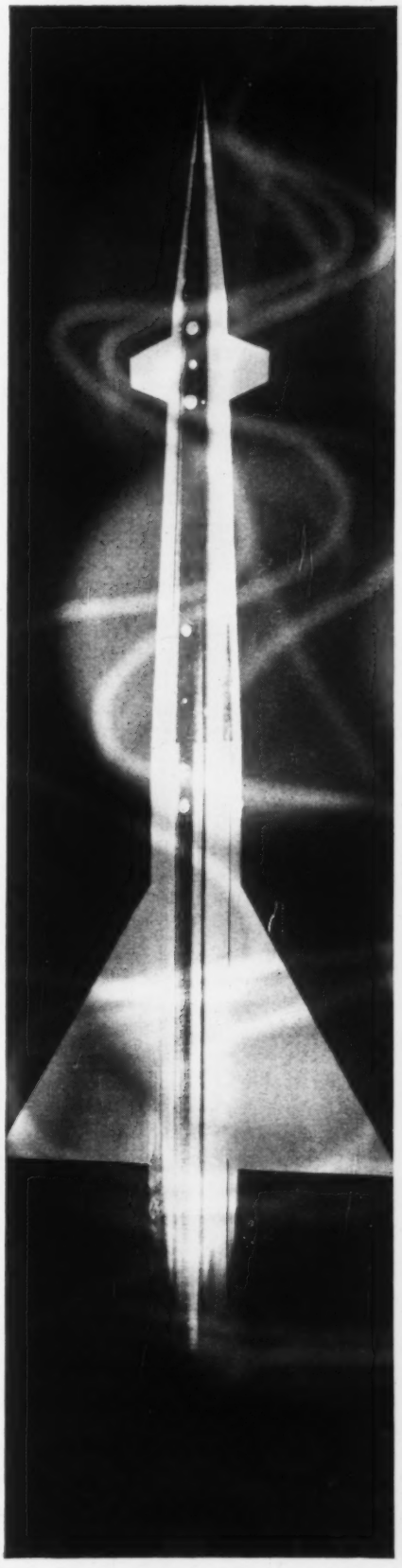
you have knowledge, enthusiasm and imagination—tempered with judgment. You're both research and production-minded—a dreamer and a doer at the same time. At every level of experience, you'll have an opportunity to conceive and activate an idea. Then prove it—a better way!

And you'll do it in a management climate that stimulates personal growth—and rewards it with the responsibility, professional recognition and material benefits limited only by your own ability. Your own academic stature can be constantly enlarged by our Educational Refund Plan...and some of the nation's finest universities are nearby.

Write today for full particulars. If you're the man we're seeking we'll be glad to arrange a personal interview where you are now residing.

Write: Mr. A. Brunetti, Autonetics Engineering Personnel, Dept. 911, Box AN, Bellflower, California.



ADVANCEMENT IS RAPID WHERE GROWTH IS RAPID

Chief Engineer Robert Ashby, 44, is one of our nation's top electronics scientists. He holds AB and MA degrees in Physics from Brigham Young, a Ph.D. in Physics from the University of Wisconsin. His hobbies are Southern California year-round "naturals"—golf and swimming.

Lester Kilpatrick received his BSEE from Texas Tech in 1946, his MSEE from M.I.T. two years later. During 8 years at North American, he has earned a national reputation as an authority on digital computers. With his wife and 4 year old son, he likes to spend week ends "at the beach."

Navy vet E. A. O'Hern joined Autonetics in 1951 after earning his BS, MS and Ph.D. from Purdue University. A Research Supervisor, he has developed advanced techniques for analysis of autopilot-controlled flexible airborne vehicles. His hobbies include baseball, basketball and music.

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AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

1500 VOLT

single junction

welded case

SILICON

RECTIFIERS

from

Texas Instruments

You can now obtain maximum rectifier miniaturization along with nearly *double* the operating voltage previously obtainable from silicon rectifiers – with new TI *single element* grown junction silicon rectifiers. This two-fold advance – single element construction plus 1500-volt operating voltage – results in immediate extension of design limits in guided missile and other military applications. Also, these welded case rectifiers are ideal for use in series in cathode ray tube power supplies and similar high voltage circuits.

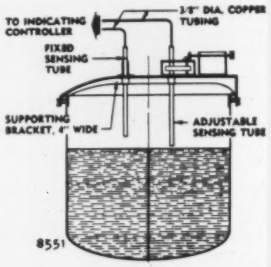
TI miniaturized silicon rectifiers feature forward current ratings to 125 ma and operate stably to 150°C. They require no filament power . . . no warm-up time. Five production types give you a choice of axial and stud half-wave types in welded case and full-wave plug-in model.

Write today for complete information

TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

For more information circle **67** on inquiry card.

second tube, installed well above level, compensates for any change in ambient pressure. Back pressure is used

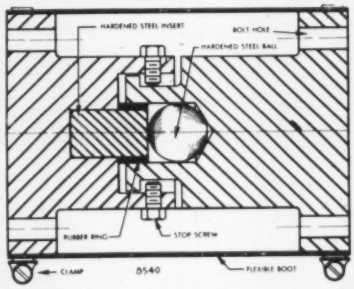


to control level with a simple on-off system. Proportional or time delay control is also possible.—*General Glass Equipment Co., 5 S. Virginia Ave., Atlantic City, N. J.*

For more information circle **223** on inquiry card.

WEIGHTING-SYSTEM PIVOT

New ball-pivot assembly supports one or more points of a tank or bin in maker's Hydraulic Weighing System. It is for use in those applications where it is not necessary to support the load at every point with maker's Load Cells.—*The A. H. Emery Co., Pine St., New Canaan, Conn.*



For more information circle **224** on inquiry card.

PRESSURE AND VACUUM

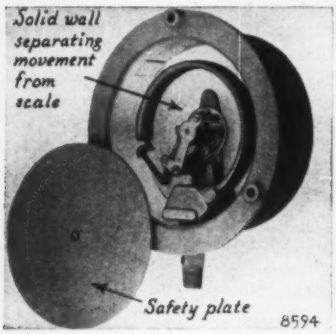
LOW-PRESSURE OR VACUUM PRECISION CONTROLLER

New industrial "Cartesian Manostat #10" is of special value in instrument field for high-precision pressure calibration, constant-pressure or vacuum chambers and precise flow control in gaseous systems. Based on Cartesian diver principle (inverted float in mercury) it requires no additional equipment. Once vacuum or pressure is set, setting will not be disturbed even if system is closed down and later reopened. Unique balanced orifice preserves sensitivity at high capacity and permits direct or reverse action in the same instruments.—*Manostat Corp., 20-26 N. Moore St., New York 13, N. Y.*

For more information circle **225** on inquiry card.

PRESSURE INSTRUMENTS

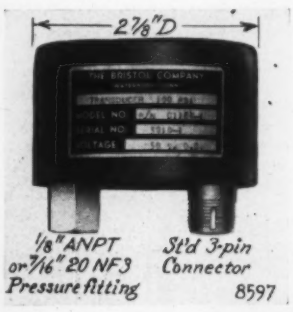
New line of pressure and vacuum gages in 3½", 4½", 6" and 8½" aluminum, brass and phenol condensate cases, includes gages for use with steam, ammonia, corrosive chemicals, etc.; comprises "Regular" gages, "Regal" gages for heavy duty, "Royal" gages for extra-heavy duty; a safety gage (illustrated); diaphragm attachments in various materials (Teflon or Kel-F coated if desired); pressure snubbers, gage cocks; needle valves; electric contacts for alarm or control. ★New line of pressure recorders can be furnished in 8", 10", and 12" case sizes in all ranges with charts from 12 hours to 7 days; with up to 4 pens; also with electric contact feature.—*Weksler Thermometer Corp., Dept. WC-1, 195 E. Merrick Rd., Freeport, L. I., N. Y.*

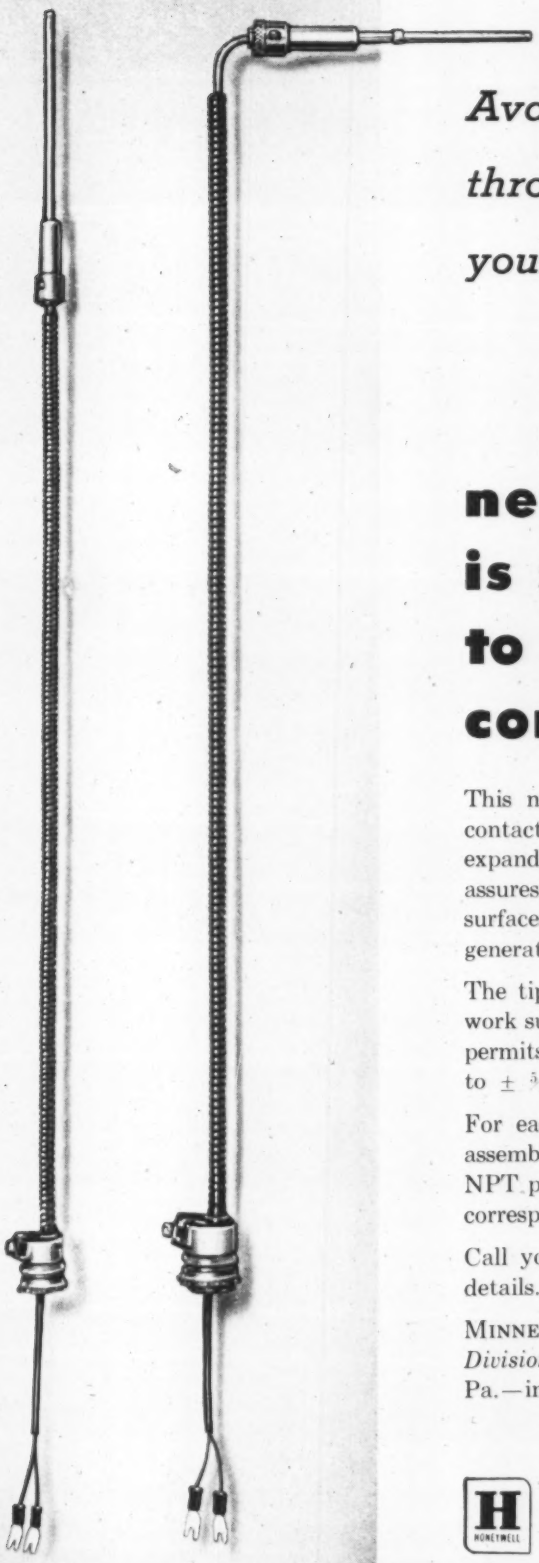


For more information circle **226** on inquiry card.

PRESSURE PICKUP

New low-cost pressure pickup for both airborne and ground applications and for a wide variety of fluids (incl. all jet and piston engine fuels) weighs 6 oz. Feature is that electric output can be either linear or to any





Available in either straight or 90° angle construction for ease of installation.

Available through your...

HSM
HONEYWELL SUPPLIES MAN

new thermocouple is spring loaded to maintain continuous contact

This new Honeywell thermocouple keeps in continuous contact with the work surface, even though the surface may expand, contract or become displaced during operation. It assures accurate temperature measurement of internal surfaces such as those of plastic extrusion machines or generator bearings.

The tip of the thermocouple is held securely against the work surface by an *Inconel-X* spring. Moreover, the spring permits insertion of the thermocouple in holes varying up to ± 5/16" from the specified depth.

For easy inspection and replacement, the thermocouple assembly is provided with a bayonet adapter to fit a 1/8" NPT pipe connection. The assembly itself is fitted with a corresponding cap to engage this adapter.

Call your nearby Honeywell Supplies Man for complete details. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

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MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

ELECTRICAL ENGINEERS

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Here are the facts: Whether or not you have previous nuclear experience, your present professional competence can be the springboard to an outstanding career in developing nuclear power systems for aircraft because . . .

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GENERAL ELECTRIC

NEW INSTRUMENTS

desired curve. Standard pressure ranges 0-2 psi to 0-250 psi (others can be supplied); voltage-dividing resistor cards in resistance ranges from 0-2000 ohms to 0-20,000 ohms; current rating of a typical VDR is 10 ma at 5200 ohms. Models with resolution of better than 0.1% are available.—*The Bristol Company, Waterbury* 20, *Conn.*

For more information circle **227** on inquiry card.

HIGH PRESSURE PICKUP

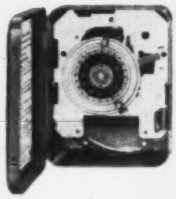
New "Model P2G" magnetic-reluctance-principle diaphragm-type pressure pickup is available in full-scale ranges from 1000 to 10,000 psig; operates in recording and control systems compatible with inductance-ratio input devices; makes possible static and dynamic pressure measurements to 1%. High natural frequency and single-degree-of-freedom pickoff suspension suppress spurious mechanical resonances in measurement of

pressure transients. All surfaces exposed to working fluid are 416 stainless, permitting direct use with corrosive liquids and gases at temperatures from −65°F to 250°F. For extreme corrosion resistance, an 18-8 type on special order. Weight 18 oz; diameter 1¾"; over-all length 3⅝". —*Pace Engineering Co.*, 6914 *Beck Ave., North Hollywood, Calif.*

For more information circle **228** on inquiry card.

TIME, SEQUENCE, FREQUENCY, COUNTING

CYCLE TIMER



New "Series C8301-S Intermatic Cycler 12," for controlling on-off cycles from 10 seconds to 12 minutes, will accommodate up to 12 sets of on-off trippers on its time dial; is infinitely adjustable through 90% of its 12-minute range; is available for 125-v operation; capacity 1875 watts.—*International Register Co.*, 2624 *W. Washington Blvd., Chicago* 12, *Ill.*

For more information circle **229** on inquiry card.

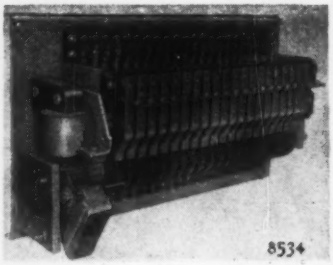
ELECTRONIC TIMER

New improved design of maker's "Type ET" features matched industrial housings for various mounting conditions. In "Type ETH" (boxed sheet-metal housing) front now permits access to terminals for fast wiring changes. Other changes: "slide-out chassis" with plug-in tube and capacitor and a complete upgrading of components. Range 60 milliseconds to 60 seconds.—*General Control Co.*, 1205 *Soldiers Field Rd., Boston* 34, *Mass.*

For more information circle **230** on inquiry card.

SEQUENCE CONTROLLER

New "MT Series Heavy-duty Step Switch" for industrial application, has contact ratings of 10 amp. Rotary solenoid actuating coil operates on 115 vac without rectifiers. Available

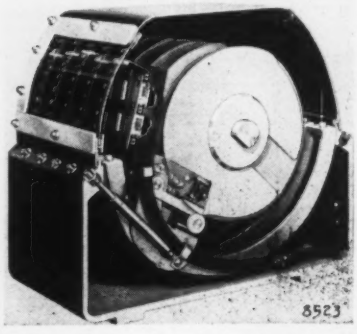


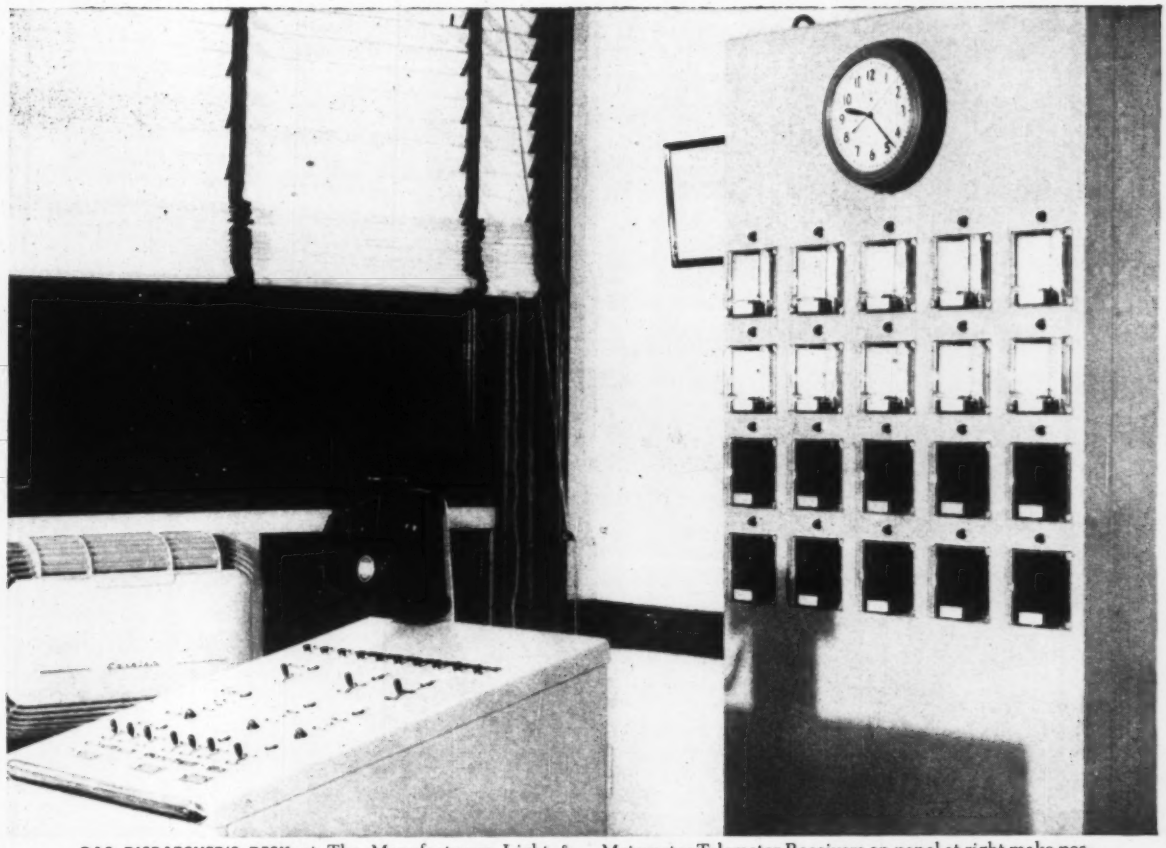
with one to twenty independent circuits. Independent cam-operated contacts make it possible to set up any combination or group of combinations. In many cases, new device eliminates use of auxiliary relays and other electrical components; provides a positive interlock between sequence operations. Basic mechanism has served under extreme environmental conditions for millions of operations. —*Eagle Signal Corp., Moline, Ill.*

For more information circle **231** on inquiry card.

SEQUENCE CONTROLLER

New "Bulletin 102 Type AL Rotating Cam Limit Switch," for precise synchronization of multiple operations, has 15-amp contacts; features positive micrometer-screw ad-





GAS DISPATCHER'S DESK at The Manufacturers Light & Heat Company's Pittsburgh office. The miniature Bristol Metameter Telemeter Receivers on panel at right make possible this ultra compact installation.

New miniature telemeters!

BRISTOL instruments make possible complete installation in small space.

Gas dispatcher at Manufacturers Light & Heat Co., Pittsburgh, Pa., does a full-sized job *in a fraction of usually required space.*

The miniature Bristol Metameter Telemeter Receivers in this highly integrated, compact station give the gas dispatcher eight continuous pressure readings from three remote regulator stations—from 7 to 30 miles away. Switches on the console let the dispatcher raise or lower the downstream pressure at any stations.

And all this in the office space taken up by two stenographer's desks!

Bristol Metameter® Telemeters—full-size or compact—can solve your remote measurement and automatic control problems as they have for hundreds of users in utilities, pipeline companies, and manufacturing industries. You'll find a Bristol system for every application: pressure, vacuum, liquid level, flow, temperature, static and differential pressure, motion, voltage, current, power and totalized load. For complete information write: The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.

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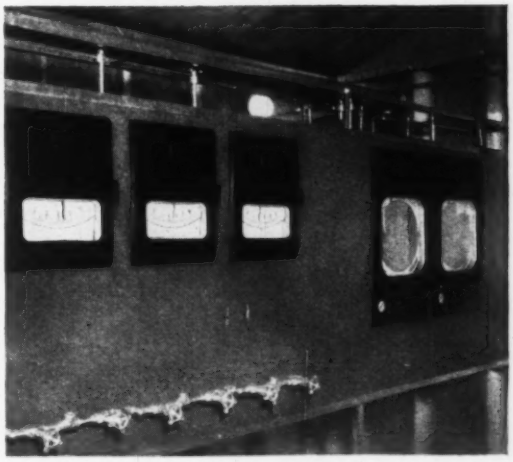


REMOTE REGULATOR STATION. Three Bristol Metameter transmitters (left) and two Bristol Series 500 pneumatic controllers transmit data to dispatcher—miles away—and automatically carry out his instructions.

BRISTOL

TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **70** on inquiry card.

Reliability for the heart of your electro-hydraulic servo control system

Typical Sanders high-flow servo valve installation.

In the development of automatic control systems involving position, velocity or force, Sanders Associates maintains a completely equipped electro-mechanical and hydraulic laboratory devoted to systems engineering.

The hearts of these systems are the various Boot-Strap* electro-hydraulic servo valves designed and built by Sanders. From the largest (0-400 GPM) to the smallest (0-1 GPM), these valves can be integrated into any complete system requiring high frequency response, reliability and simplified operation.

For both industrial and military application, Sanders electro-hydraulic control systems have a record for reliable performance under extreme environmental conditions. If you are seeking maximum efficiency for similar systems, Sanders engineers are glad to contribute their experience to your needs. Simply write to Dept. IA-1.

Vital control functions performed by Sanders Electro-Hydraulic Servo Valves

- Aircraft and missile control systems.
- Atomic-powered submarine steering and diving systems.
- Anti-aircraft gun systems.
- Aircraft test facility systems.
- Rocket and jet engine fuel control systems.
- Widely varied process control systems.

*T. M. Sanders Associates

SANDERS ASSOCIATES INCORPORATED
NASHUA NEW HAMPSHIRE

For more information circle **71** on inquiry card.

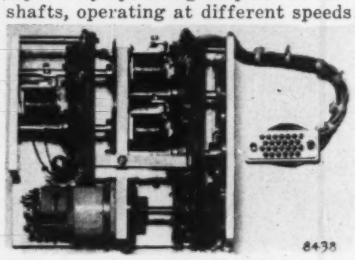
NEW INSTRUMENTS

justment of each individual switch mechanism in relation to its cam. This adjustment can be made with a screwdriver, from outside, while switch is in motion. Made in three standard sizes accommodating up to five, nine, or twelve individually-adjustable cams. Contact assemblies can have two sets of contacts. Speed limit 100 rpm.—*Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio.*

For more information circle **232** on inquiry card.

PROGRAM CONTROLLER

New Sequence Timer features six separately-operating wipers on five shafts, operating at different speeds:



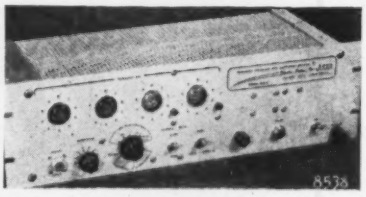
8438

three are relay-actuated and three are constantly-rotating intervalometers. Relay-actuated wipers are connected to clutch plates kept from rotating by a relay-operated ratchet. When a pulse is received by relay, ratchet is pulled, thereby permitting clutch plate and wiper to make one revolution. Switches handle currents up to 6 amp at 28 vdc, will withstand 1000 v. Instrument will stand 20 *G* or higher. —*Motronics Corp., 241 Concord St., Glendale 3, Calif.*

For more information circle **233** on inquiry card.

FREQUENCY COUNTER

New "Model 7340B Frequency Indicator and Counter," developed specifically for industrial applications, is



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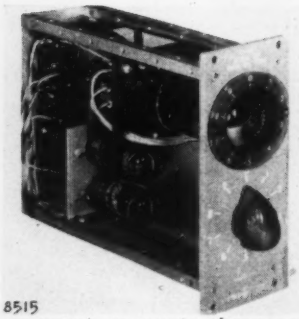
a new and improved version of previously-available "Model 7340A." Features: 50-mv input sensitivity, counting rate to 60 kc; gate times of 1 or 10 sec; automatic recycling or single sample operation; manual gate control for longer sampling times or totalizer operation; indication to 10,000 events per second; automatic decimal point location.—*Electro-Pulse, Inc., 11861 Teale St., Culver City, Calif.*

For more information circle **234** on inquiry card.

ELECTRONIC COUNTER

New "Model 166" plug-in strip for totalizer applications provides an accurate register in programs involving



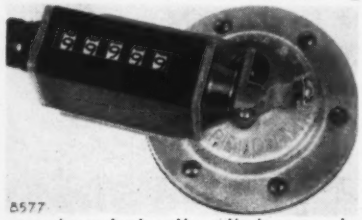
8515

measurements or counts where speeds are too great for mechanical counters. Features: scale factor 1 to 10; max speed 4 kc; resolution of 250 usec. Input requirements: minimum amplitude + 15 v, minimum rise rate 1 v per usec, minimum pulse width 100 usec; input impedance 220 k.—*Baird Associates-Atomic Instrument Co., 33 University Road, Cambridge 38, Mass.*

For more information circle **235** on inquiry card.

FLUID-OPERATED COUNTERS

New counting devices for pneumatically or hydraulically controlled operations screw into line controlling



8577

any air or hydraulic cylinder; can be completely installed in five minutes. It is claimed that new device "will outwear and outperform mechanical counters yet sells for a total cost of less than the usual installation cost." Models are available for 1 to 5,000 psi and up to 300 counts per minute. —*Pneumaticount, 3400 N. E. 54th Ave., Portland, Oregon.*

For more information circle **236** on inquiry card.

HIGH-SPEED COUNTER

New "Model F 106HD" panel-mounting electrical impulse counter for especially heavy duty operation

8447

features maximum counting rate of 40 per second with electronic drives or electromechanical actuators and resistors in series. For dc operation only with coils from 6 to 220 v. Power consumption 8 watts.—*Presin Co., 12128 W. Pico Blvd. Los Angeles 64, Calif.*

For more information circle **237** on inquiry card.

FREQUENCY STANDARDS

TYPE 50

AVIONIC
FREQUENCIES
PRECISION FORK

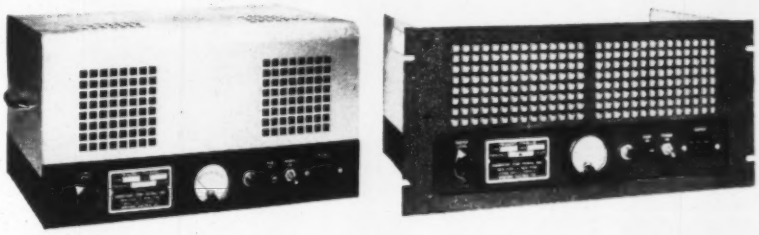
FREQUENCIES
240–400–500–1,000 cy.

ACCURACIES
Type 50 ±.02% (—65° to 85°C)
Type R50 ±.002% (15° to 35°C)

Requires double triode and 5 pigtail components

Size, 1" diameter x 3¾" high
Weight, 3.5 ounces

POWER
75 Watt
FREQUENCY STANDARD
TYPE 211C



FREQUENCIES: .....50 to 1,000 cycles
ACCURACY: ..±.002% (+15° to +35°C)
OUTPUT: .....115V, 75 Watts
INPUT: .....110V, 50 to 75 cycles
SIZE: with cover....10"x17"x9" high
PANEL model,..10"x19"x8¾" high
WEIGHT: .....25 pounds

INDUSTRIAL

FREQUENCY STANDARD
TYPE 50L

FREQUENCIES
50–60–75 or 100 cy.

ACCURACIES
TYPE 50L
±.02% (—65° to 85°C)
TYPE R50L
±.002% (15° to 35°C)

INPUT: 150 to 300V, B (6 V at .6 amps.)
OUTPUT: .....2V into 200,000 ohms.
SIZE:..3¾"x4½"x5½" high. Wgt., 2 lbs.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government, (armed forces) where maximum accuracy and durability are required.

American Time Products Inc.
580 Fifth Avenue, New York 36, N. Y.

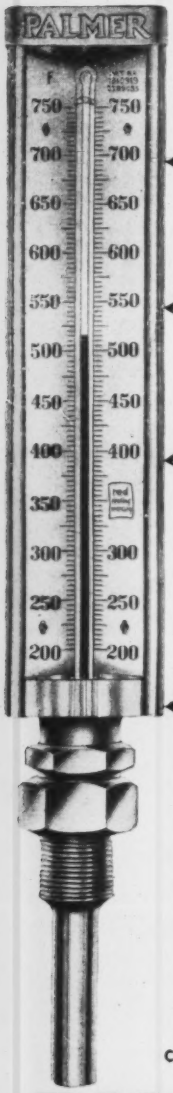
American Time Products, Inc.
580 Fifth Ave., New York 36, N. Y.
Gentlemen: Please send details on your Type_____
Name_____
Company_____
Address_____
City_____

For more information circle **72** on inquiry card.

Today's Modern Industry
Demands a Modern Thermometer

PALMER

RED-READING MERCURY THERMOMETERS



Red-Reading Mercury

Extruded Brass Case

Chrome Finish

Ranges -40 to 950°F or Equivalent in °C

Write for Complete Information

Ask for Bulletin No. 35

Consult your Classified Directory

PALMER

THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

Cincinnati 12, O.

For more information circle 73 on inquiry card.

COMPUTING and DATA PROCESSING

PUNCH-TAPE-PROGRAMMED ANALOG COMPUTER

New "1100 Series EASE" analog computers combine a digital output-input translator system (DO/IT) with other new features designed for automatic operation and high accuracy. By using a typewriter and punched tape system to set up and check problems, new computers save hours of operating time, take much of the human element out of computing, and make practical an installation of any size. Electric typewriter system permits complete computer control—including pot set and electronic function generator set-up. Solutions can be run and re-run automatically with the punched tape. Two patch bays are available: a 2200-hole board for a 60-amplifier computer ("Model 1132") and a 3,600-hole board for a 100-amplifier installation ("Model 1133"). Pushbutton monitoring of all amplifiers and coefficient pots is a standard feature; optional features include pushbutton monitoring of multiplier, function generator and resolver outputs; potentiometer arms, trunk lines, and power voltages. Computing resistors and capacitors are adjusted to better than 0.005% and mounted in a temperature-controlled oven set at 113°F. —*Dept.* 5939, *Berkeley Div., Beckman Instruments, Inc.*, 2200 *Wright Ave., Richmond* 3, *Calif.*

For more information circle **238** on inquiry card.

TAPE INPUT-OUTPUT UNIT

New high-speed paper tape console comprises a 440-character-per-second photoelectric reader and a 60-charac-

ter-per-second punch; makes possible an 1800% increase in input speed and a 500% increase in output speed of "ALWAC III-E Electronic Digital Computing System." It also increases "ALWAC III-E" system's range of applications, now extended to include unlimited storage of data on inexpensive paper tape. Modular construction permits purchase of either punch or reader if application does not require both.—*Logistics Research Inc.*, 141 *South Pacific Ave., Redondo Beach, Calif.*

For more information circle **239** on inquiry card.

INPUT-OUTPUT TYPEWRITER

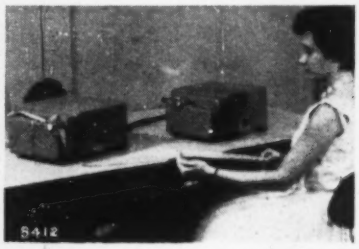
New model of maker's electric typewriter, designed for use as an input and output device for data processing,

types 120 words a minute; can be used in conjunction with computers as well as with indicating and recording instruments, scales, etc. Carriage lengths up to 30".—*International Business Machines Corp.*, 590 *Madison Ave., New York* 22, *N.Y.*

For more information circle **240** on inquiry card.

TAPE DUPLICATOR

New high-speed "Punched Paper Tape Regeneration Unit," consisting of "Motorized Tape Punch" (left)

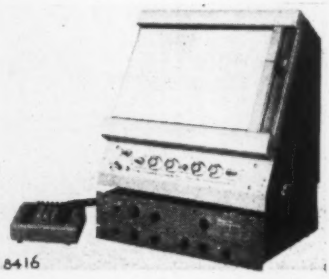


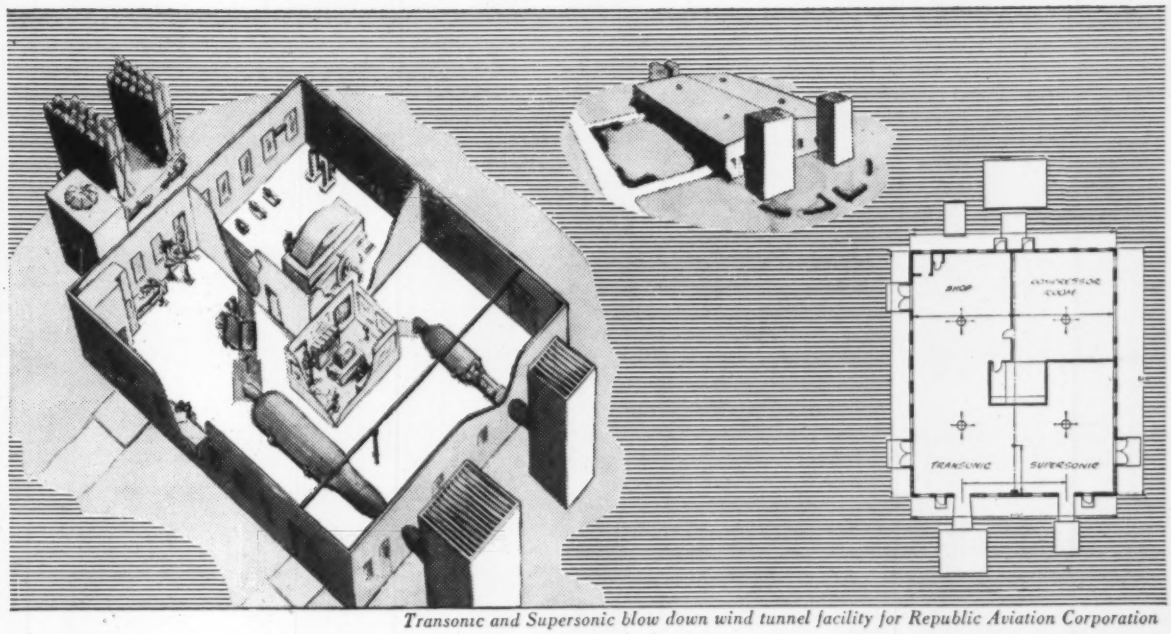
cable-connected to "Motorized Tape Reader," duplicates 5-, 6-, 7- or 8-channel tape at rate of 1200 codes per minute, producing a composite tape for wire-transmission, computer input, recording instruments, etc., where one long tape accelerates data processing.—*Commercial Controls Corp.*, 1 *Leighton Ave., Rochester, N. Y.*

For more information circle **241** on inquiry card.

X-Y RECORDER KEYBOARD

New "Model 75" 10-key keyboard accessory for maker's 11"x17" *X-Y* recorders comprises a 10-key keyboard and a rack-mounted program and





Transonic and Supersonic blow down wind tunnel facility for Republic Aviation Corporation

a special message to wind tunnel engineers and scientists

ANNOUNCING UNUSUAL OPPORTUNITIES WITH REPUBLIC'S NEW WIND TUNNELS SECTION OF THE R & D DIVISION

A new wind tunnel installation doesn't open every day!

Yet, that's exactly what's happening at Republic Aviation. A brand-new installation is being planned for Farmingdale, Long Island, dedicated to the study of all the complex, interrelated aspects of passage through the upper atmosphere.

What can this mean to you?

If you're presently a Director or Assistant Director of a wind tunnel installation, it means an opportunity to change pace — to express your ideas — and then implement them — in brand new facilities. And at the same time, to broaden your professional horizons.

Or perhaps you're a member of the operating staff at a wind tunnel. You've got experience, ability, intelligence. But you'd like a chance to get in on the ground floor of a new operation, with the most modern facilities at your command... and increase your opportunities from the very start.

If you're in any of these categories, you owe it to yourself — and your family — to check the following requirements and then contact us.

DIRECTOR: Should have 10 to 15 years' experience in the design, construction and operation of wind tunnels and related facilities, as well as complete staff administration.

STAFF: Preference will be given to people with direct or related experience, at all levels, in wind tunnel

PLANNING • PROGRAMMING • TEST OPERATION
ANALYSIS • INSTRUMENTATION

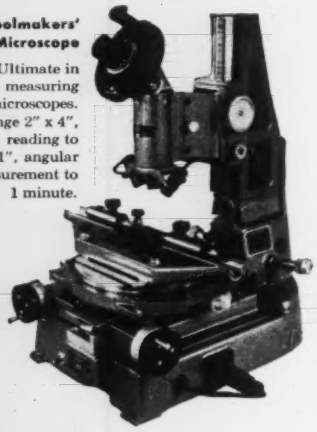
Republic engineers and scientists enjoy top-of-industry pay scales plus added financial and professional recognition for individual contributions. Benefits include our famous 2-Fold Retirement Income Plan. Educational Aid, and broad Life, Accident and Health Insurance Program. Unequalled Long Island Living, with all the cultural, educational and entertainment facilities of New York just minutes away.

Please send complete resume, in strictest confidence, to:
Mr. D. G. Reid, Engineering Personnel Manager.

REPUBLIC AVIATION
FARMINGDALE, LONG ISLAND, NEW YORK

Toolmakers' Microscope

Ultimate in measuring microscopes. Range 2" x 4", reading to 0.0001", angular measurement to 1 minute.



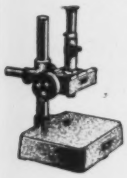
Precise measurement to 0.0001"

Slash rejects, save money with Gaertner measuring microscopes

Precise, versatile, easy-to-use Gaertner measuring microscopes assure positive, direct measurement of precision parts. You see clear, sharply-defined images. No physical contact to distort or injure object being measured. Enjoy new production savings with Gaertner optical instrumentation. Write for complete data on the Gaertner line of industrial microscopes.

Coordinate Measuring Microscope

High precision, low cost instrument for 2-dimensional linear measurement. Range 2" x 2", reading to 0.0001".



Micrometer Slide Comparator

Reliable, low cost instrument for linear measurement. Ranges up to 4", reading to 0.0001" or 0.00005".

Scale Micrometer or Shop Microscope

High quality, low cost instrument with range up to 0.100". Reading to 0.001", easy interpolation to 0.0002".

Write for Bulletin 161-54 showing applications, models, specifications.

The Gaertner Scientific Corporation

1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

For more information circle **74** on inquiry card.

NEW INSTRUMENTS

memory unit. Keyboard uses touch system and can be operated by either left- or right-hand operators. Optional: "Model 250" symbol generator which permits six character symbols to be manually selected by a switch position on memory-program unit. No mechanical attachments required.—*Electro Instruments, Inc., 3794 Rosecrans, San Diego 10, Calif.*

For more information circle **242** on inquiry card.

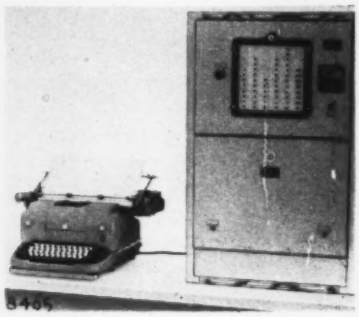
DATA PRINTERS

New models of maker's numerical data printers of both serial and parallel entry types, for use in automation and data processing systems, are available in capacities from 8 to 11 digits; can take input in various forms, manual or remote, and deliver it in equally diverse forms. Solenoids perform all operations which might normally be accomplished manually. Machines can be operated from externally applied pulses of the required voltages to make an entry or initiate a control system; can print, add and convert remote input into perforated tape or cards.—*Electronics Division, Clary Corp., San Gabriel, Calif.*

For more information circle **243** on inquiry card.

TELEMETERING SYSTEM WITH SERVO-WRITER

New converter equipment to operate a solenoid-actuated typewriter unit is available to supplement "Varec

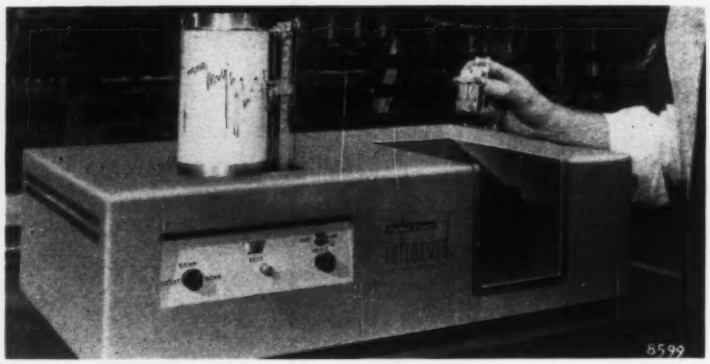


Pulse Code Receiver." Thus data are logged to permit accurate inventory control and printed report can be used by accounting department. Also available is automatic scanning: liquid level, temperature, date and time are reported tank-by-tank, sequentially, until an entire tank farm has been covered.—*Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif.*

For more information circle **244** on inquiry card.

LABORATORY EQUIPMENT

DOUBLE-BEAM INFRARED SPECTROPHOTOMETER

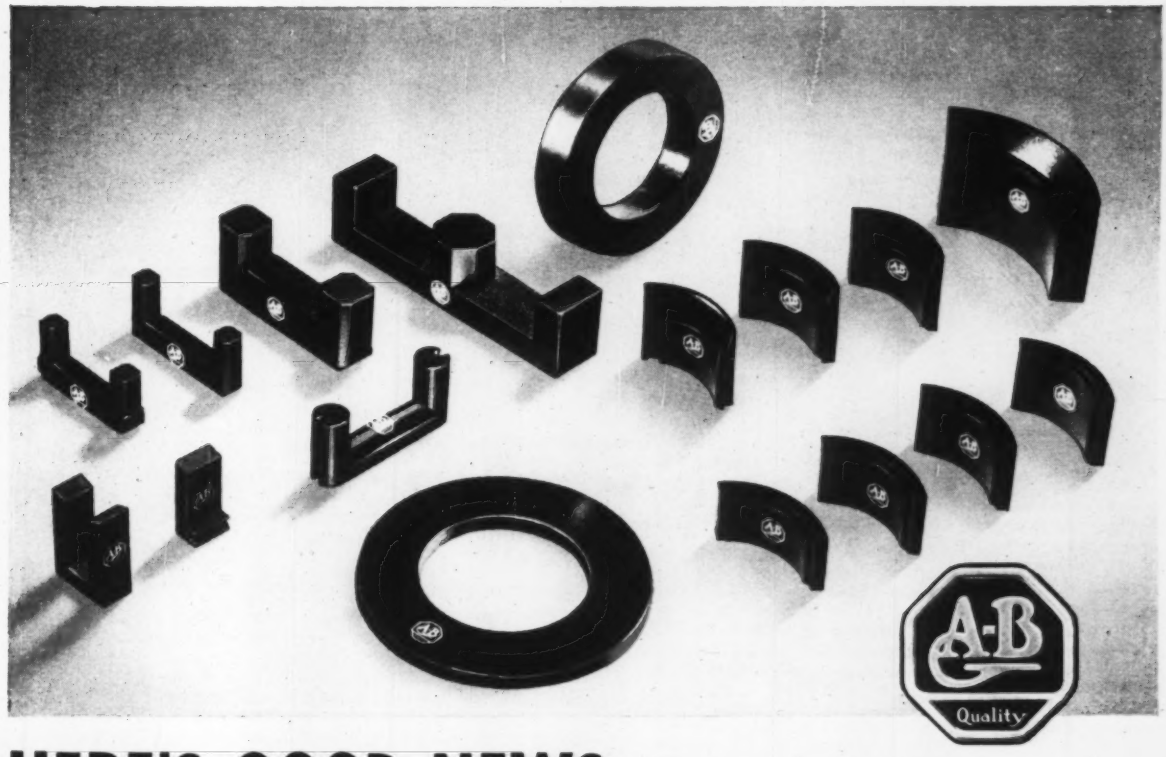


New low-cost but versatile "Infracord," for use by the organic chemist at his bench and also by colleges, will sell for "about a third of the cost of double-beam infrared instruments now being marketed." It can be used for fast purity checks of raw materials, for recording the progress of an organic synthesis, for molecular structure elucidation and for precise quantitative analysis. It is far less complicated to use than an analytical balance. Spectral range 2.5 to 15.0 microns; resolution 0.05 micron at 10 microns; wavelength accuracy 0.03 micron throughout rock-salt region; wavelength reproducibility better than 0.01 micron; noise level 1%; quantitative accuracy 1%. *Perkin-Elmer Corp., Norwalk, Conn.*

For more information circle **245** on inquiry card.

CORROSION-RATE ANALYZER

New "Corrosometer" measures electrically the progress of corrosion in any corrosive system. Probes of more than 30 metals and alloys are supplied in a number of designs to meet different pressure and temperature conditions. Three models: "Model C", portable field unit operated by batteries; "Model K", for use where ac is available; "Model R", continuous recording unit. Principle: measuring loss of metal directly in microinches



HERE'S GOOD NEWS
about ALLEN-BRADLEY FERRITES!

Allen-Bradley ferrites have been discovered to be superior for deflection component applications in television receivers. As a result, the demand has kept Allen-Bradley in delivery troubles—a situation that has been annoying to both customers and ourselves. Therefore, you will be glad to learn that Allen-Bradley's production capacity has been considerably expanded—our shipment problems should be a thing of the past.

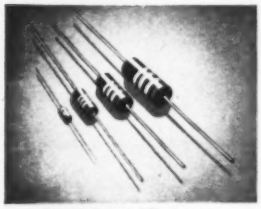
Comprehensive tooling for practically every size and shape of ferrite core currently being used in both black and white and color television receivers, makes Allen-Bradley an ideal source for your ferrite core requirements.

Use Allen-Bradley Class WO-1 ferrites for deflection yoke application and Class WO-3 ferrites for flyback transformer applications and enjoy superior TV receiver performance.

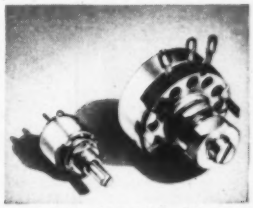
Uniform dimensions of Allen-Bradley ferrites enable low-cost, efficient assembly. Uniform magnetic characteristics eliminate necessity of individual adjustments or compensations.

Allen-Bradley Co., 140 W. Greenfield Ave., Milwaukee 4, Wis. • In Canada—Allen-Bradley Canada Limited, Galt, Ont.

OTHER QUALITY COMPONENTS FOR RADIO, TV & ELECTRONIC APPLICATIONS

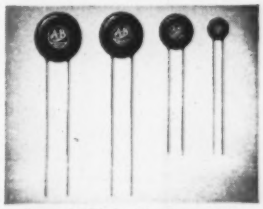


Fixed Molded Resistors
1/10, 1/2, 1 & 2 watt



Variable Molded Resistors
1/2 & 2 watt

Stand-off and Feed-thru capacitors

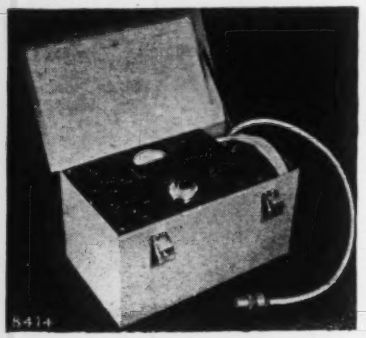


Ceramic Dielectric Capacitors for by-pass and filtering

ALLEN-BRADLEY
RADIO, ELECTRONIC AND TELEVISION COMPONENTS

For more information circle **75** on inquiry card.

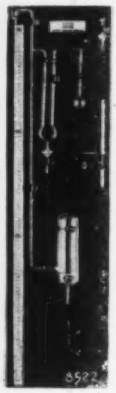
of penetration, by increase in electrical resistance as corrosion takes place. No temperature error because a reference specimen also built within probe is protected from corrosive medium by a suitable coating. Among



advantages: about 30 seconds for a reading; no shutdown to retrieve specimens because probe remains in corrosive system at all times; corrosion rates determined in hours or days rather than weeks or months; only this method permits measurement of both uninhibited and inhibited corrosion rates on the same metal specimen without removing it from its environment.—*Crest Instrument Co., 11808 S. Bloomfield Ave., Santa Fe Springs, Calif.*

For more information circle **246** on inquiry card.

VAPOR-PRESSURE ANALYZER

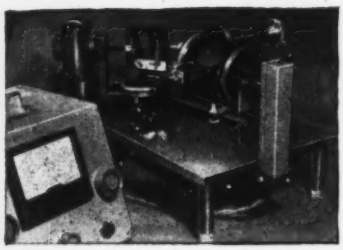


New "Cenco Vapor Pressure Apparatus" increases accuracy of low-temperature fractional analyses by eliminating holdup error and uncertainties in determining cutpoints; is used to analyze binary mixture collected between plateaus of any two fractions and provides information regarding composition of the original mixture. It takes transition fraction obtained from low-temperatures distillation of sample and analyzes it further by vapor-pressure method.—*Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.*

For more information circle **247** on inquiry card.

THIN-FILM-THICKNESS PHOTOMETRIC GAGE

New "Quantum Ellipsometer," for accurate measurement of extremely thin film thickness (down to molecular dimensions) is a polarizing spectrometer that can measure directly the thickness of films which can be deposited on suitable substrates. It fills gap between molecular-layer dimensions and micron dimensions where other instrument readings be-



gin to be usable. It opens up new areas of investigation in chemical, physical and biological sciences as well as in quality control, etc.—*Quantum, Inc., 756 No. Brooksvale Road, Cheshire, Conn.*

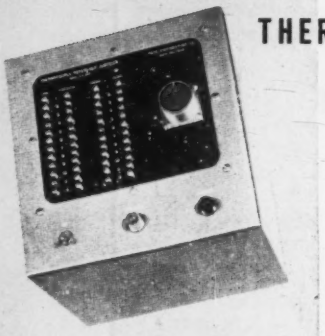
For more information circle **248** on inquiry card.

LAB STOPCOCK

New "Lab-Crest" stopcock requires no stopcock grease: customary glass plug has been replaced by a precision-machined Teflon plug whose "non-freezing" operating property provides unique self-lubrication while maintaining a leakproof seal. Possibility of product contamination due to stopcock grease is eliminated. New stopcock operates smoothly over a wide temperature range; is suited for

PACE

THERMOCOUPLE REFERENCE JUNCTION



RJ SERIES THERMOCOUPLE REFERENCE JUNCTIONS operate from 115 volt line to provide thermostatically controlled temperature reference for multi-channel thermocouple systems. Reference Junction permits use of copper lead wire without inconvenience of ice-bath maintenance, and eliminates necessity for cold-junction compensation.

Features...

Temperature stability within ½°F, and uniformity within 0.1°F.
Control temperature adjustable.
Multi-wire junctions available for thermocouple choice in each channel.
Variety of thermocouple types, number of channels and input-output connections offered in standard models.

PACE *engineering company*

6914 Beck Avenue, North Hollywood, California • Phone POplar 5-0453

For more information circle **76** on inquiry card.

Vector

Tube Socket Test Adapters

TEST CIRCUITS IN OPERATION

ROTOPROBE

Switching type tube socket test adapter—with permanently attached test lead, and numbered stop positions for each pin.

Measurements are made on each contact by turning the shell of the Rotoprobe to the corresponding number on the index.

TUBE SOCKET TEST ADAPTERS With radial test tabs

TUBE SOCKET TEST ADAPTERS Long type for tight spots

SOCKET CHANGE ADAPTERS Change tube types without rewiring

SOCKET EXTENDERS Replaceable socket extends life of test equipment

Write for catalog—

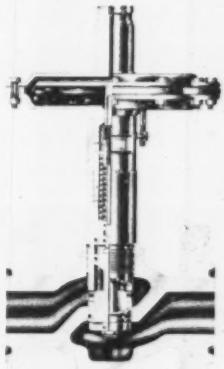
VECTOR ELECTRONIC COMPANY

3352 SAN FERNANDO ROAD, LOS ANGELES 65, CALIFORNIA
TELEPHONE CLinton 7-8237

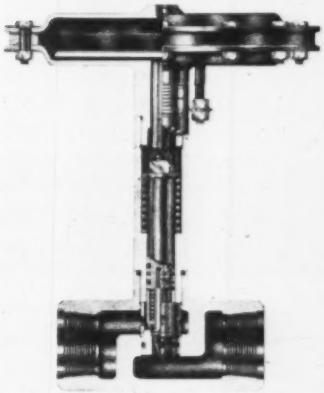
For more information circle **77** on inquiry card.

got

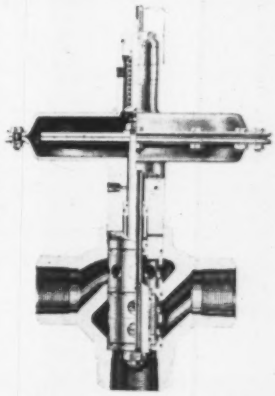
DIAPHRAGM MOTOR VALVES



TYPE "DCB-1." Pressure balanced, soft or hard seats, screwed or flanged, for working pressures to 10,000 psi.



TYPE "DA-TS." Pressure regulating valve with enclosed soft seat.



TYPE "CPC." Three-way, three-position, center position closed. Pressure-balanced disk, single diaphragm, guaranteed bubble-tight closure.

TYPE "TC." Low pressure, economy-priced, for gas or fluid service.

Over ten years service in the toughest proving grounds in the world is your assurance of dependable performance from GOT Motor Valves. Furnished in air-to-open and air-to-close types, with interchangeable hard or soft seats, these valves have exclusive design and construction features that simplify installation and maintenance, and permit their use in a wide variety of flow control services. Pressure-balanced types handle up to 10,000 psi working pressure with a single seat and single diaphragm, with guaranteed bubble-tight closure! Three-way, two-position and three-way, three-position valves permit automatic diversion of flow, with bubble-tight closure if required. Economy-priced low pressure valves reduce your original investment and provide unexcelled service within their pressure ranges. Angle valves simplify piping where right angle discharge is required.

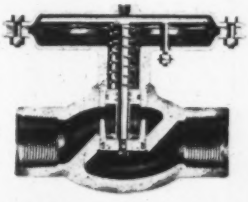
All GOT Motor Valves feature all-steel construction; enclosed stems; inner valves that may be removed without removing the valve body from the line, and without disturbing the diaphragm. High pressure types utilize "huddling chamber orifices" which protect the inner valve against cutting, and permit re-sizing without the necessity of seat and disk replacement. Primary control is provided by GOT time-cycle or pressure-sensitive pneumatic, electric or electro-pneumatic controllers.

Write today for Catalog No. 256 MVC. It contains full information on GOT Motor Valves and Controllers, and points out many ways in which they will save money in your plant operations.

REPRESENTATIVES IN PRINCIPAL CITIES THROUGHOUT THE UNITED STATES AND ABROAD

Garrett Oil Tools, Inc.
P. O. BOX 2427 • LONGVIEW, TEXAS

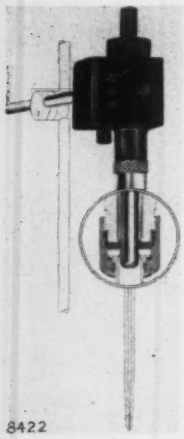
USI
DIVISION OF U. S. INDUSTRIES, INC
New York, N. Y.



For more information circle **78** on inquiry card.

pressure applications and handling of hazardous liquids. (Normal vacuum applications also.)—*Glass Div., Fischer & Porter Co., Hatboro, Pa.*

For more information circle **249** on inquiry card.



8422

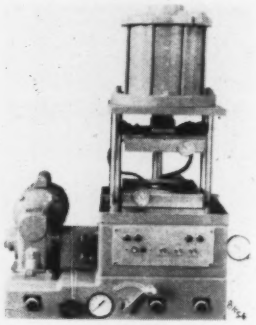
DIGITAL MICROBURETS AND PIPETS

New mechanical counter replaces dial gages on all styles and models of "Gilmont Ultra-Microburets and Pipets," permits easy reading to 1 part in 10,000.—*Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.*

For more information circle **250** on inquiry card.

MOONEY VISCOMETER

New "Model STI Mooney Shearing Disc Viscometer" features new ease of operation and maintenance, improved stability of proper operating condition, and added safety features. It supplements "NBS Mooney" world standard for evaluating elastomeric compounds for "Mooney Values"

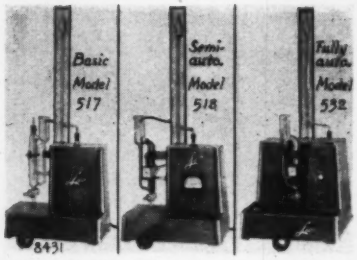


(viscosity, scorch and cure characteristics).—*Scott Testers, Inc., 45 Blackstone St., Providence, R. I.*

For more information circle **251** on inquiry card.

SULFUR TITRATORS

Three new sulfur titrators, for combustion-titration procedure, feature elimination of titration stopcock: titration is accomplished by means of electronically-controlled coarse and fine push buttons. Added features include an improved method for adding starch, and a simplified manifold push button for adding solutions to buret and titration vessel. Each unit will operate independently of existing combustion furnaces, regardless of model, type or make.—*Laboratory Equipment Corp., St. Joseph, Mich.*

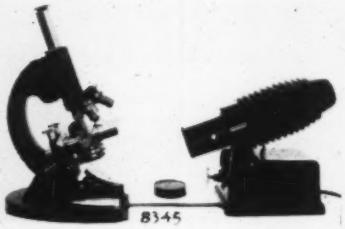


8431

For more information circle **252** on inquiry card.

PHASE-CONTRAST MICROSCOPE

New "Bleeker Phase-Contrast Microscope" combines light weight, high rigidity, attractive design and smooth fine focusing. Drum is finely adjusted into 50 parts, each corresponding to a stage shift of one micron. Built-in



8345

NEW HI-VOLUME AIR SAMPLER

accurately samples the air for radioactive material, particulate matter, etc.

Hundreds used in Atomic Energy tests, and by Industries employing, developing and manufacturing nuclear products . . . Literally "inhales" an entire area with unparalleled speed and accuracy . . . Particles as small as 1/100th a micron in diameter have been accurately sampled by this unit . . . Portable . . . Designed for indoor and outdoor use . . . Indispensable for series or unit tests. 24 V, 110 V, & 220 V models available.

For details about this new scientific method

THE Staplex CO.
AIR SAMPLER DIVISION
784—5th Ave., Brooklyn 32, N. Y.

For more information circle **79** on inquiry card.

OPTICAL COATING LABORATORY, INC.
OCLI

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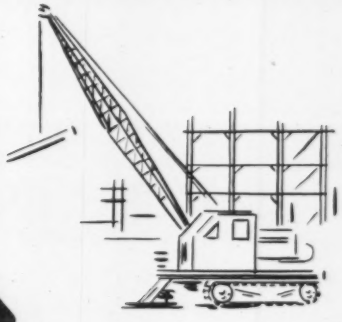
For more information circle **80** on inquiry card.

MISSILES to MACHINERY

Century MODEL 420 ELECTROGRAPH

covers the oscillograph recording field



TELEMETRY APPLICATIONS

- QUICK-LOOK monitoring in the telemetry ground station permits continuous observation of missile in-flight programing results.
- ON-THE-SPOT monitoring permits making in-flight function corrections in controlled missiles or piloted aircraft.
- A NATURAL for mobile telemetry vans . . . compact, rugged, low power consumption, record is PERMANENT, no fading or fogging when exposed to direct sunlight.

INDUSTRIAL APPLICATIONS

- STRESS-STRAIN RECORDING with "first-hand" read-out during test.
- PERMANENT record obtained at test site may be stored indefinitely for purpose of future data reduction.
- PORTABLE — extremely useful for field test applications where a "multiplicity" of data must be collected with the least amount of instrumentation.
- No amplifiers required for many applications.

USES a variety of tubular mirror galvanometers pioneered by Century

ENGINEERS . . .

Check your requirements against these FEATURES!

- Permanent continuous record produced within recorder.
- Developed record may be viewed an INSTANT after exposure.
- HIGH CONTRAST photographic qualities . . . black intelligence traces are recorded on light colored background.
- As many as 24 intelligence channels may be recorded on the 8-inch x 200-foot record roll.
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- Eliminates need for costly darkroom facilities.

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● Crow Electri-Kits are tailored to individual needs—from Basic Electricity to specialized courses in Advanced Electronics. You start at your own proficiency level and progress as far and as fast *as you want.*

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For more information circle **82** on inquiry card.

NEW INSTRUMENTS

stop protects microslides. Objectives are completely dustproof.—*Karl Heitz, Inc.*, 480 *Lexington Ave., New York* 17, *N. Y.*

For more information circle **253** on inquiry card.

PHOTOGRAPHY

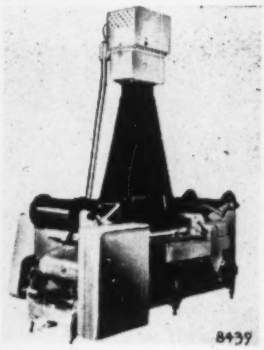
35-MM CAMERA

New "Asahiflex Model IIA" single lens reflex 35mm camera, said to be "the world's greatest camera value,"

features single-lens reflex; interchangeable lenses; pre-set aperture; synchronization *F* and *X;* Speeds ½ to 1/500 second, T & B; High Speed, Telephotos to 500mm lenses and various accessories available.—*Burke & James Inc.*, 321 *South Wabash Ave., Chicago* 4, *Ill.*

For more information circle **254** on inquiry card.

ELECTRONIC PHOTOPRINTER



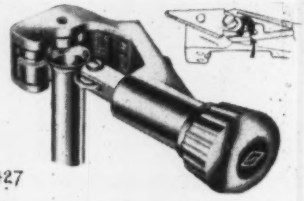
New "Type T231 Automatic Electronic Photo Printer" is said to utilize revolutionary electronic control in "dodging" negatives during printing. It prints with a brilliant spot of light which scans negative and photoprinting material. Variations of density are sensed and evaluated in electronic circuits which compare light value with that required to give best possible print for photoprinting material in use. This information is fed back instantaneously to control intensity of printing beam automatically and correctly exposes each small area of the negative.—*Norden-Ketay Corp.*, 99 *Park Ave., New York, N. Y.*

For more information circle **255** on inquiry card.

SHOP EQUIPMENT AND MATERIALS

TUBE CUTTER

New "Hi-Duty Tube Cutter" includes a spare cutting wheel concealed in a recess behind reamer, is for use

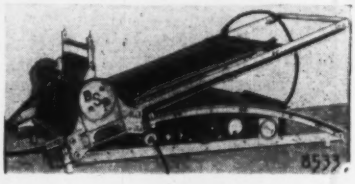


with copper, steel or aluminum tubing from ⅛" to 1" OD.—*Imperial Brass Mfg. Co.*, 1200 *W. Harrison St., Chicago* 7, *Ill.*

For more information circle **256** on inquiry card.

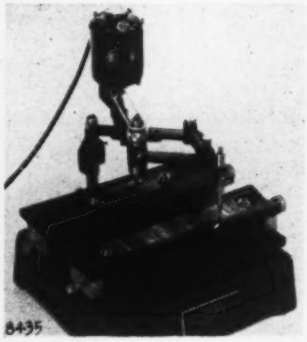
CIRCUIT PRESS

New "Mark III Junior" press, developed for laboratory methods research to prove out prototype printed circuit designs which can be duplicated in large-scale production, prints dry: panels come off press ready for etching. No baking or racking problems. Printing can be accomplished on single or double copper clad laminate up to ⅛" thick.—*Dry Screen Process Inc.*, 1016 *Madison Ave., Pittsburgh* 12, *Pa.*



For more information circle **257** on inquiry card.

HEAVY-DUTY PANTOGRAPH

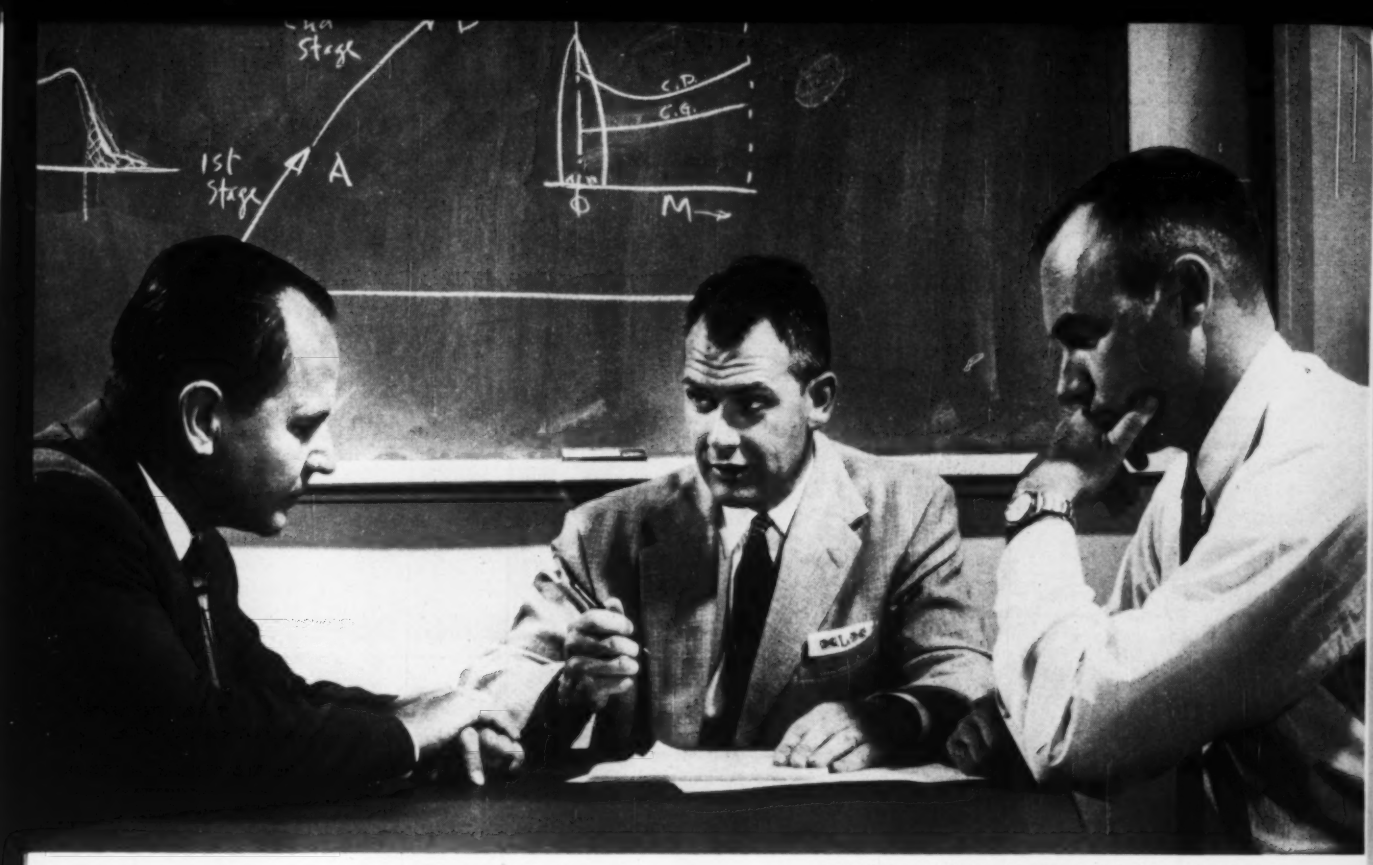


New "No. 624" (interchangeable with maker's standard "No. 600") was developed for heavier work in continuous service; can engrave six sizes of characters from a single master.—*Mico Instruments Co.*, 86 *Trowbridge St., Cambridge* 38, *Mass.*

For more information circle **258** on inquiry card.

PREFORMED SOLDERS

New facilities are announced for supplying manufacturers with preformed solders in any shape or size,



L. K. Edwards (center), advanced design and systems analysis department head, discusses launching of a ballistic missile with W. P. Gruner (left), head of weapons systems integration, and Systems Analyst G. W. Flynn.

the creative approach to MISSILE SYSTEMS ANALYSIS

There are few areas in which engineers and scientists can apply their abilities so broadly as in Lockheed's concept of systems analysis. Lockheed systems analysis staff members engage importantly in virtually every phase of missile preliminary design and development as they:

- formulate overall analytical treatment
- perform original analyses when problems defy conventional handling
- coordinate analytical activities among different departments

Because Lockheed is involved primarily in frontier activities, its systems analysis emphasis is on new approaches, new techniques, new ideas. It is work that calls for flexible, creative minds.

Inquiries are invited from engineers and scientists possessing those attributes. Positions are open at both Van Nuys and Sunnyvale, California, centers.

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MODEL 59-LF OSCILLATOR UNIT

Frequency Range:
100 Kc to 4.5 Mc.
Price - Oscillator Unit (Head) only $98.50
with Power Supply
$168.00

MODEL 59 OSCILLATOR UNIT

Frequency Range:
2.2 Mc to 420 Mc.
Price - Oscillator Unit (Head) only $98.50
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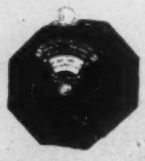
MODEL 59-UHF OSCILLATOR UNIT

Frequency Range:
420 Mc to 940 Mc.
Price - Oscillator Unit (Head) only $123.00
with Power Supply
$198.00



Measurements' Megacycle Meter is now available in a choice of three oscillator heads providing frequency range coverage from 100 Kc to 940,000 Kc. Thus, the utility of this versatile instrument has been extended, making it, more than ever, indispensable to anyone engaged in electronic work; engineer, serviceman, amateur or experimenter.

Laboratory Standards

MEASUREMENTS CORPORATION
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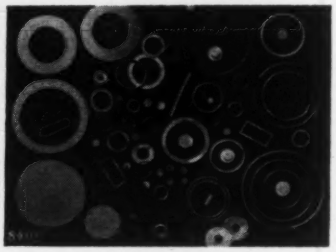
For more information circle **83** on inquiry card.

NEW INSTRUMENTS



all these shapes available in Alpha "Cen-Tri-Core" energized rosin-filled solder, "Uni-Core Leak-Pruf" acid-cored solder, single core, solid wire, and sheet solder.—*Alpha Metals, Inc., 56 Water St., Jersey City, N. J.*

For more information circle **259** on inquiry card.

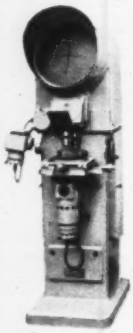
LOW-STRAIN PYREX

New re-annealing process for Pyrex glass minimizes traces of strain. It is said that "Pyrex brand No. 7740, manufactured by Corning Glass Works, is one of the most widely used types of glass, and in its commercially annealed state it is adequate for most purposes. However, for exacting scientific needs, a glass with considerably less strain is required. By using special annealing equipment, with extremely delicate controls, our engineers can greatly reduce the strain for scientific requirements." Glass produced by this new annealing process is designated "Hayward Fine Anneal."—*Dept. N, Hayward Scientific Glass Corp., 217 Magnolia Ave., Whittier, Calif.*

For more information circle **260** on inquiry card.

DIMENSIONAL GAGING, INSPECTION

OPTICAL COMPARATOR

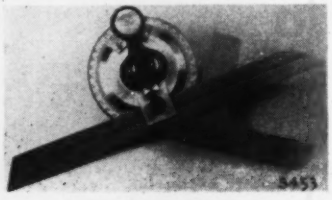


New optical comparator lowers inspection costs by speeding examination of tolerance limits of small precision parts; features "Nikkor" lens system which makes possible an extremely bright, undistorted and evenly-illuminated image. Comparator and lenses are made by Nippon Kogaku K. K., Tokyo. Different magnifications can be quickly obtained by revolving turret. Parfocal lenses have magnification powers of 10x, 20x, 31¼x, 50x, 62½x, and 100x; are specifically built for precise image resolution, even in periphery of field. Object to be examined can be illuminated from below or above from a vertical or oblique position. When illuminated from above (an important feature of new comparator), surface topography of object can be examined for texture, finish, corrosion, etc. Three models: "Model 1 and Model 11C" are bench models; "Model 111" (illustrated) floor stand pedestal type. —*Nikon, Inc., 251 Fourth Avenue, New York 10, N. Y.*

For more information circle **261** on inquiry card.

BEVEL PROTRACTOR

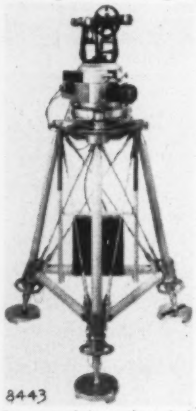
New model of maker's "Universal Vernier Bevel Protractor" has an adjustable magnifier for ease of reading. To eliminate glare, measuring dial is "Lustro-Chrome" finished. Protractor comes regularly with 6" blade. Additional accessories available are blades in 8" and 12" length, acute angle attachment, and a stand.—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*



For more information circle **262** on inquiry card.

ALIGNMENT THEODOLITE

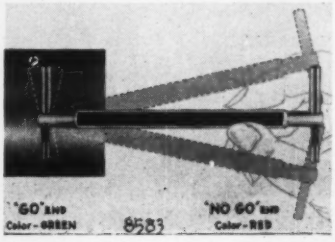
New "Azimuth Alignment Theodolite" permits alignment of precision gyroscopes to 2 seconds of arc by continuously observing reflections from a mirror mounted on monitored unit. Error signals in theodolite are applied, automatically or manually, as corrective signals to gyroscope's drive elements.—*Perkin-Elmer Corp., Norwalk, Conn.*



For more information circle **263** on inquiry card.

INTERNAL GAGE

New "Holojust Adjustable Hole Gage" checks bore diameter, out-of-roundness and bell-mouth at any

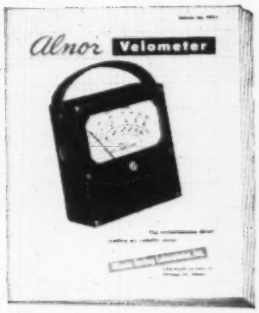


FREE

ILLUSTRATED BULLETIN

How you can save time by measuring air velocities with an

ALNOR VELOMETER



Developed to facilitate quick and easy determination of air velocities, the Alnor Velometer is a compact, precision instrument that provides instantaneous, direct readings in feet per minute, without timing, calculations or reference to conversion tables. Guaranteed accurate, in ranges from 20 f.p.m. to as high as 24,000 f.p.m. Also available with metric or miles-per-hour calibrations.

Tear out this ad and mail it with your business letter head to Illinois Testing Laboratories, Inc., Room 518, 420 N. LaSalle St., Chicago 10, Ill.

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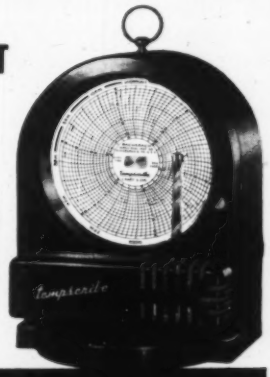
PRECISION INSTRUMENTS FOR EVERY INDUSTRY

For more information circle **85** on inquiry card.

For Accurate TEMPERATURE RECORDS at MODERATE COST

RANGES AVAILABLE	
Temperature Range	One Rotation of Chart
−30° to +120°F	7 Days
−30° to +120°F	24 Hours
−20° to + 40°F	24 Hours
−20° to + 40°F	7 Days
−10° to + 50°F	24 Hours
−10° to + 50°F	24 Hours
30° to 60°F	7 Days
40° to 100°F	24 Hours
40° to 100°F	24 Hours
60° to 90°F	8 Hours
60° to 90°F	24 Hours
70° to 130°F	24 Hours
−25° to + 10°C	24 Hours
5° to 40°C	24 Hours



Use TEMPSCRIBE Recorders

The TEMPSCRIBE self-registering Recording Thermometer meets a long-felt need for a moderately priced recorder for general purpose applications where a graphic record of temperature in surrounding air is required. The record—written on an easy-to-read chart, 4" in diameter, with graduations spaced uniformly over full range—is indispensable wherever knowledge is desired if temperature goes above or below any given point. TEMPSCRIBE is the only recorder made with pen and actuating element in door, which, when opened, permits a clear view of the complete chart, and easy chart replacement without danger of damaging pen arm or accidentally marking chart.

Write for Bulletin 704

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For more information circle **86** on inquiry card.

PANEL SPACE LIMITED? SPECIFY

DIALCO® 2-Terminal Sub-Miniature Pilot Lights

COMPACT

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OMNIDIRECTIONAL PLASTIC DOMES

COMPLETELY INSULATED

Also available with "Taper-Tab" quick-connect terminals

Also

1-Terminal Pilot Lights

for use on grounded circuits. Available with *binding screw* or *soldering* terminal.

DIALCO's expanded line of sub-miniature lights conform to all applicable Mil Specs. Use T-1¾ midget incandescent lamps—1.3 to 28 V. Spring mounted *Lens-with-Message* is readily positioned *after* installation... Mount from *back* of panel in 15/32" clearance hole; or from *front* of panel in 17/32" hole... 7 lens colors... Shown approx. actual size (top to bottom): No. 134-3830-375-6... No. 101-3830-951... No. 101-5030-951... No. 109-3830-111... No. 111-3830-111... No. 107-1930-951.

Complete details in Brochures L-156 A and L-157.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Foremost Manufacturer of Pilot Lights

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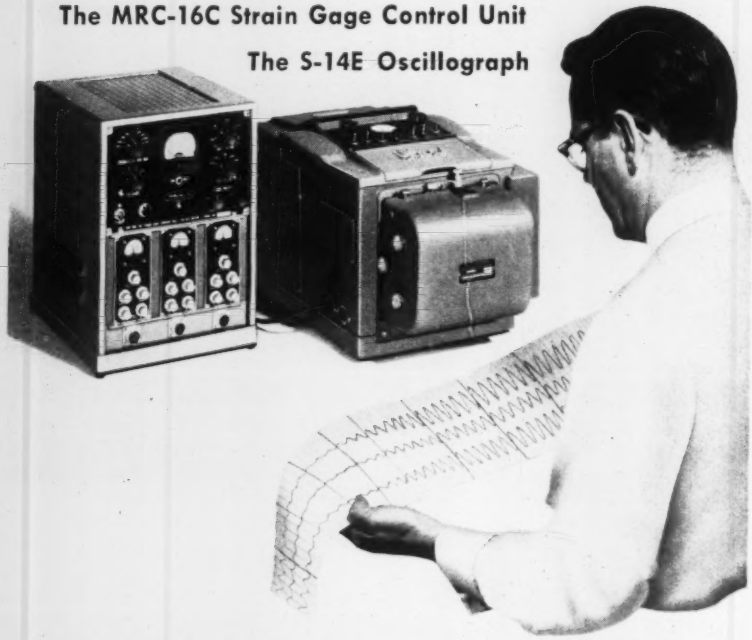
For more information circle **87** on inquiry card.

BASIC SYSTEM
for Dynamic Analysis

The MRC-16C Strain Gage Control Unit

The S-14E Oscillograph



IN CONTINUOUS RECORDING of static or dynamic quantities, the Hathaway MRC-16C Strain Gage Control Unit and the Hathaway S-14E Oscillograph have no equals. The accuracy, portability and clear, clean records produced by these two units working together make this instrument team your best possible investment.

SPECIFICATIONS

THE MRC-16C

AMPLIFIER ELEMENTS: Available for use in any combination.

Carrier Amplifier: 0 to 1500 cps

Wide Band Amplifier: 2.5 to 6000 cps

CONTROL UNIT

Voltmeter: Has 2 scales for continuous monitoring of carrier or gage voltage and serves as a bridge balance indicator.

Power Supply: Supplies filament and regulated plate voltages to the oscillator and amplifier elements from 115 volt, 60 cycle.

Gage Factor Control: Continuously adjustable over a range of 1.9 to 2.2.

SIZE: 15 x 12 x 16 inches

WEIGHT: 50 pounds

THE S-14E

VERSATILE RECORDING CHANNELS: Uses any combination of 6 to 24 coil, bifilar or multi-element type galvanometers.

AUTOMATIC LAMP-BRILLIANCE CONTROL: Insures clear records.

CHART DRIVE SYSTEM: Quick change transmission—a range of 9 speeds easily selected—1/10 to 600 in/sec.

CONTINUOUS DRIVE RECORD MAGAZINE: Accommodates 6 inch record of any desired length up to 300 feet.

POWER: 115 volts; 50-60 cycles

WEIGHT: 60 pounds

OPTIONAL ACCESSORIES:
Synchronous time marker
Record numbering device
Trace identifier
Drum-type record magazine with high-speed shutter attachment

Write for Bulletins 4-6H and 1-4H

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For more information circle **88** on inquiry card.

depth depending on length of handle, up to about 5". Bores located one behind another, of equal or unequal diameters, can be checked. Holes requiring micro finish can be inspected without leaving marks. Full set of 5 gages covers total range from $\frac{7}{16}$" to $2\frac{5}{16}$"; single gages are obtainable. —*George Scherr Co., Inc. 200 Lafayette St., New York 12, N. Y.*

For more information circle **264** on inquiry card.

MECHANICAL TESTING

PRECISION DYNAMOMETER

New "HDE-100 Servo Dynamometer," for testing servo-mounted miniature and sub-miniature motors, fea-

tures maker's "Hysteresis Brake" to absorb motor power, with accurate torquing system wherein running torque of test motor is balanced against swing of a carefully calibrated pendulum weight. Available in maximum torque scales down to 0.5 oz-in and up to 6.0 oz-in with maximum error of 1% full-scale. Motor is held in integral sliding mount by use of adapter rings made in all standard servo sizes (or adapter blanks can be machined). Unit will test for: free running speed without external sources of mechanical or electrical drag on test motor; torque and corresponding speed; stall torque; starting torque, drop-out speed and torque, and all static and dynamic characteristics.—*Magtrol, Inc., 88 Virginia Pl., Buffalo, N. Y.*

For more information circle **265** on inquiry card.

FULLY AUTOMATIC HARDNESS TESTER

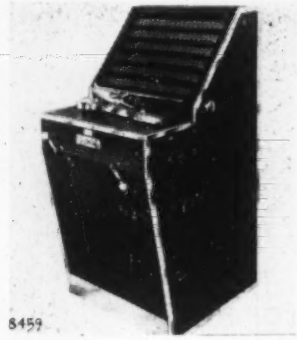
New "Size 3 Console Model Fully Automatic Hardness Tester" makes it possible to automatically classify

up to 1000 Rockwell tests per hour on large production runs by hand-feeding individual pieces; performs basically on same principle as maker's hand operated units; will test any metal on regular Rockwell scale. Workpieces can be tested in one of two ways: manual feed and manual disposal; and semi-automatic, with manual loading and automatic disposal and classification as to hardness. Single tests can be performed by snapping a switch to change cycle from continuous to single-operation. —*Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.*

For more information circle **266** on inquiry card.

TORQUE TESTER

New "Optical Torque Tester," which may be "the first full-range industrial production torque wrench



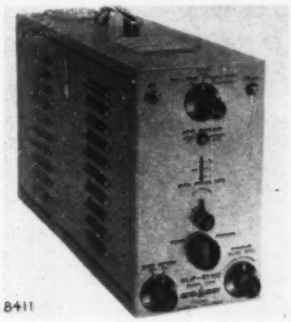
8459

tester," features a torsional shaft measuring element submerged in heated oil which provides constant operating temperatures for measuring. Any torque wrench can be tested to full capacity in seconds, or it can be checked rapidly over each increment marking on scale range. Three models, each with two ranges, cover all types of torque wrenches.—*P. A. Sturtevant Co., Addison, Ill.*

For more information circle **267** on inquiry card.

SHAKE-TEST STROBE SYNC

New "Model 103A Slip-Sync" permits watching shake tests in slow motion, or stopped in any selected cyclic



8411

position, so that user can observe destructive mechanical resonances and analyze source of failure. ("Conventional vibration testing techniques yield only the simple fact of failure.") —*Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.*

For more information circle **268** on inquiry card.

ELECTRICAL TESTING

UNIVERSAL TEST BENCH

New universal test bench provides complete facilities for testing and quality control of electrical compo-

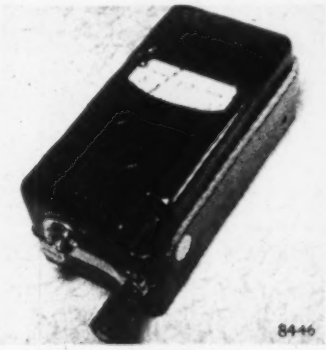
8441

nents. Instruments measure speed, time interval, voltage, current, resistance, power, torque, etc. Regulated power supplies, load banks, etc., are provided. Flexibility makes new bench particularly suitable for production testing and receiving inspection of components whose designs are frequently changed.—*Performance Measurement Co., 15301 W. McNichols Rd., Detroit 35, Mich.*

For more information circle **269** on inquiry card.

INSULATION TESTER

New insulation tester (manufactured in Denmark) is available in four different models: 125 volts-10



8446

megohms; 250-20; 500-50; 1000-200. Weight 5 lbs. A durable leather case is included.—*Pimex, Inc., 2 E. 82nd St., New York 28, N. Y.*

For more information circle **270** on inquiry card.

TRANSFORMER TESTER

New "Current Transformer Field Test Set" quickly pinpoints sources of possible trouble in short-circuiting,

load cells

based on the Statham unbonded strain gage transducer

For dynamic recording of forces during stress-strain determinations, breaking strength tests, ordinary load measurements and for indication or automated control.

TENSION-COMPRESSION
±10 to ±1,000 lbs.

COMPRESSION
0-10 to 0-1,000 lbs.

TENSION
0-10 to 0-1,000 lbs.

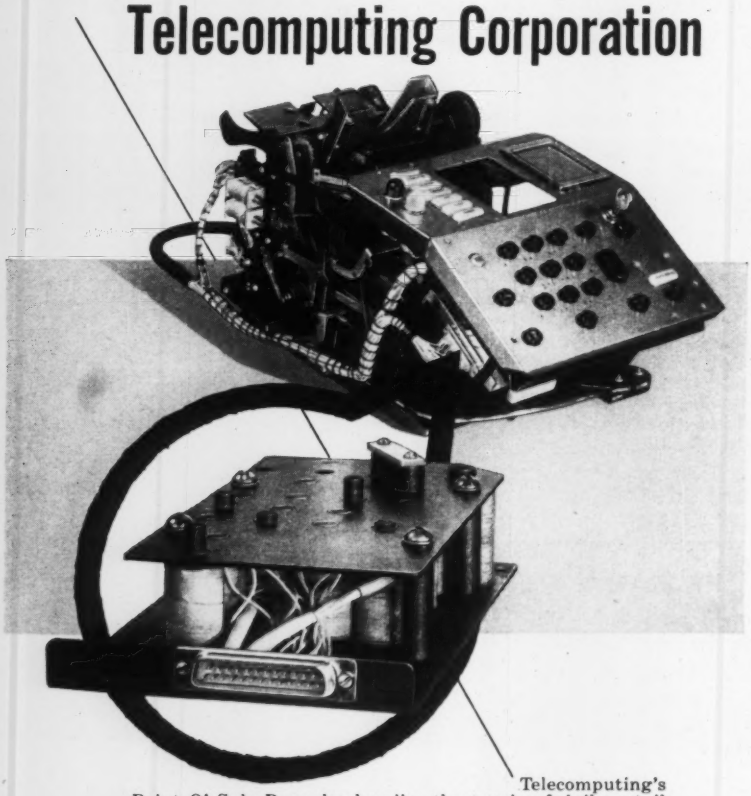
Please request Series L bulletins.

Statham
LABORATORIES
12401 W. Olympic Blvd., Los Angeles 64, Calif.

For more information circle **89** on inquiry card.

WesCo

miniature solenoids solve control problem for Telecomputing Corporation



Telecomputing's Point O' Sale Recorder handles thousands of daily retail sales automatically.

The recording operation starts at the input keyboard. Each of the eighteen keys actuates a miniature solenoid. Telecomputing engineers required solenoids which would do a big job in small space, which would be reliable, fast, accurate. They solved this problem with WESCO miniature solenoids.

Together, WESCO and Telecomputing engineers packaged the eighteen small solenoids, wiring and connectors into a module. This package fits under the keyboard of the Point O' Sale Recorder.

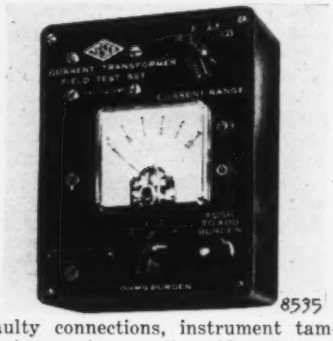
If you too, need a solenoid for maximum work in small space, WESCO has many miniature, sub-miniature, single or multiple solenoid designs for you.

THE TRADEMARK ON MILLIONS OF SOLENOIDS SINCE 1927

WesCo **WEST COAST ELECTRICAL MFG. CORP.**

233 West 116th Place • Division 123 • Los Angeles 61 • PLymouth 5-1138

For more information circle **90** on inquiry card.



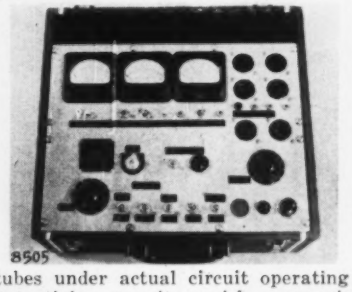
8535

faulty connections, instrument tampering, and grounding. New feature is spread of resistance burdens: 0.5, 1, 2 or 4 ohms. Lower burden values are recorded for testing small-size low-capacity current transformers widely used on low-voltage installations.—*Eastern Specialty Co.*, 3617 *N. 8th St., Philadelphia* 40, *Pa.*

For more information circle **271** on inquiry card.

THYRATRON TESTER

New "Model JB Thyratron and Phanotron Tube Analyzer," only commercial instrument of its type, tests



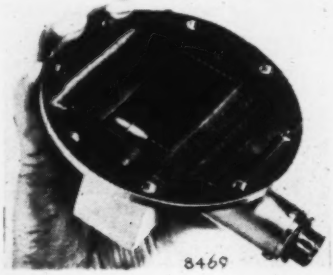
8505

tubes under actual circuit operating potentials, permits quick comparisons with tube manufacturers' specs and curves, manual adjustment of grid volts, automatic indication of critical grid volts and of critical grid current; accommodates all common industrial tubes.—*Alectric Mfg. Co.*, 7842 39*th Ave., Kenosha, Wis.*

For more information circle **272** on inquiry card.

GAS TUBE NOISE SOURCES

New miniature gas tube noise sources, for calibration and test of radars, and microwave equipment and communications systems, feature extreme compactness: unit for "S" Band being 3⅛" long, and units for



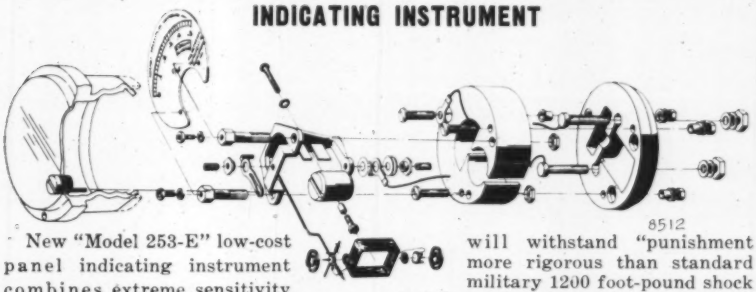
8469

higher frequencies correspondingly smaller. They pass all environmental MIL specs for shock, humidity, vibration and temperature cycling. Operating effectively from 2.6 to 40 kMc, they require no warmup time, and no correction for ambient temperatures.—*Roger White Electron Devices, Inc., 96 Fourth Ave., Haskell, N. J.*

For more information circle **273** on inquiry card.

ELECTRICAL & ELECTRONIC INSTRUMENTS

INDICATING INSTRUMENT



New "Model 253-E" low-cost panel indicating instrument combines extreme sensitivity with unusual shock resistance. Sensitivities begin with a full-scale range of 20 microamperes, yet instrument will withstand "punishment more rigorous than standard military 1200 foot-pound shock test." A number of design features are believed to be "firsts" in the instrument industry.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **274** on inquiry card.

TRANSISTOR OSCILLATOR

New "Transilator Model 125A" crystal-controlled transistor oscillator employs a pair of transistors and a unique diode feedback system in a battery-operated unit. Output frequencies of 1, 2 and 5 Mc available by rotating a selection switch; others between 1 and 5 Mc by external crystal jack. "Transilator" can be used to calibrate 'scope sweep speeds and repetition rates, radar range units, and chroma circuits.—*Kay Electric Co., 14 Maple Ave., Pine Brook, N. Y.*

For more information circle **275** on inquiry card.

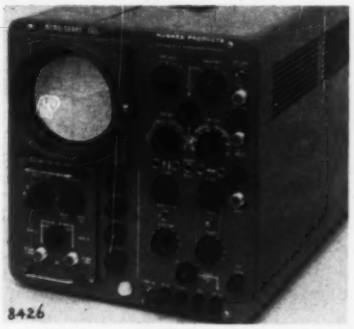
OSCILLOSCOPE KIT

New 5" oscilloscope kit, said to be "remarkably low in cost," features simplified assembly by use of a printed circuit board and laced wiring harness. Sweep range 15 to 150,000 cps in 4 ranges; vertical response down only 3 db at 700 kc (1000-cps reference); vertical sensitivity 25 rms mv/in; 1-v peak-to-peak square-wave regulated calibrating voltage; horizontal sensitivity 70 rms mv/in; internal and external positive and negative sync.—*Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.*

For more information circle **276** on inquiry card.

STORAGE OSCILLOSCOPE

New "Model 103 Memo-Scope" incorporates maker's "Memotron Ray Storage Tube," retains any number

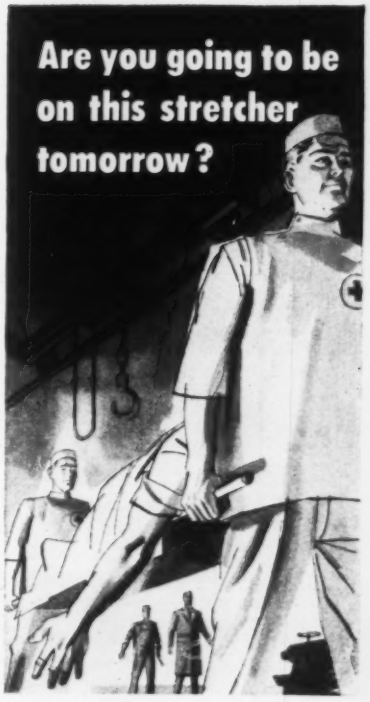


of traces indefintely at a constant intensity until intentionally erased. Traces are visible in a brightly-lighted lab and can be easily photographed. Two models: portable and rack mounted.—*Hughes Products, Electron Tubes, International Airport Station, Los Angeles 45, Calif.*

For more information circle **277** on inquiry card.

DIGITAL VOLTMETER

New low-cost "Model 131" offers design features previously available only in higher priced models: same range as "Model 451" four-digit VM; same oil-sealed stepping switch system for trouble-free life; automatic measurement from zero to ±999 vdc with automatic polarity indication, automatic



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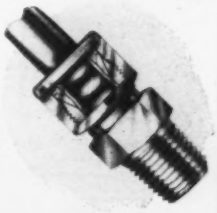

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For more information circle **91** on inquiry card.

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NEW DESIGNS & TECHNIQUES

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HIGH SPEED GAS CHROMATOGRAPHY CELL

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WESTDAHL INSTRUMENT COMPANY

Millington 8, NEW JERSEY
TEL: Millington 7-0781

For more information circle **92** on inquiry card.

RAWSON ELECTROSTATIC VOLTMETERS

Type 518

Available ranges 100 volts to 35,000 volts

Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION

Leakage resistance greater than one million megohms. These meters may be used to measure STATIC ELECTRICITY!

Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

Write for bulletin.

RAWSON ELECTRICAL INSTRUMENT COMPANY
112 Potter St. Cambridge, Mass.

For more information circle **93** on inquiry card.

NEW INSTRUMENTS

range selection and automatic readout decimal point location.—*Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.*

For more information circle **278** on inquiry card.

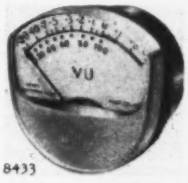
V-T MILLIVOLTMETER

New battery operated vacuum-tube millivoltmeter, available in dc and ac models, is specifically designed for field measurements of small potentials (to 50 uv) associated with corrosion problems and electrochemical, biological, medical, and geophysical tests. Essentially infinite input resistance (10 megohms) on all ranges provides minimum disturbance to circuit under test. Six full-scale ranges from 0-25 to 0-1000 mv and two additional ranges, 0-10 and 0-100 v. Entirely new circuit. Accuracy, 1.5% on all ranges, independent of tube and battery variations.—*Fisher Research Lab., Inc., 1961 University Ave., Palo Alto, Calif.*

For more information circle **279** on inquiry card.

1½" VU METER

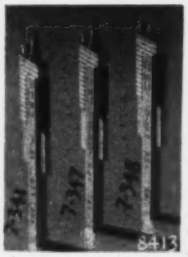
New "MM-1" self-contained VU Meter in maker's "Medalist" line requires only the panel space of a 1½" round instrument. All necessary rectifiers, associated resistors and shunts are contained within instrument housing.—*Marion Electrical Instrument Co., Grenier Field, Manchester, N. H.*



For more information circle **280** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

GALVANOMETERS

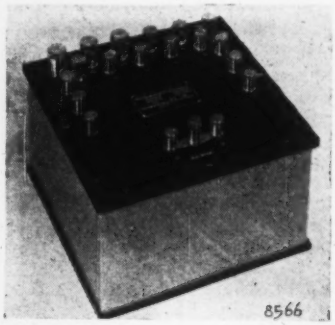


Three new units in maker's "7-340" family of galvanometers provide higher frequency response without sacrifice of sensitivity. For the same frequency range (as compared to previous galvanometers), sensitivity has been quadrupled.—*Consolidated Electrodynamics Corp., Pasadena 8, Calif.*

For more information circle **281** on inquiry card.

LAB CURRENT TRANSFORMERS

New "Type RA Precision Multirange Current Transformers" are custom-built to provide primary ranges specified by purchaser and to provide compensation and calibration for a specified secondary burden. As many as 18 ranges can be provided in one unit, and purchaser, when specifying the primary current values, can choose from 33 available ranges from 0.5 to 200 amp. Ratio and phase angle are well within a few hundredths of 1%



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Glass Tubes and Rods for Scientific Use—Lamps, Furniture, Lighting & Decorative Fixtures—Display Domes—Contract Cutters of Tube and Rod.

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For more information circle **84** on inquiry card.

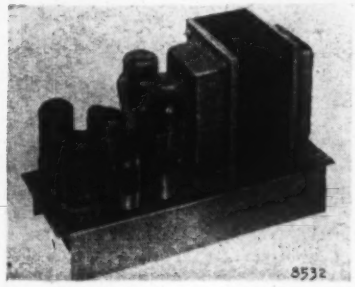
and 2 minutes. Secondary is 5 amp and is provided with a convenient short-circuiting switch. "RA" units are for use on 250-v. circuits.—*Knopp Inc., 4250 Holden St., Oakland 8, Calif.*

For more information circle **282** on inquiry card.

POWER SUPPLIES, etc.

REGULATED POWER SUPPLY

New "Model 5-300XA" sub-chassis-mounted regulated dc power supply delivers any voltage between 300 and



500 vdc by means of minor internal changes; 300 ma max; also 6.3 vac filament voltage at 6 amp max. Regulation is 0.5% for a line voltage of 105 to 125 vac; and 1% for NL to FL. Ripple is below 10 mv rms for any voltage or load within ratings.—*Dressen-Barnes Corp., 250 N. Vinedo Ave., Pasadena, Calif.*

For more information circle **283** on inquiry card.

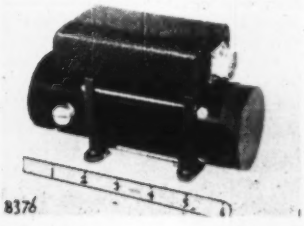
LINE FREQUENCY CONVERTER

New "1101 Converter" comprises essentially a rectifier, vibrator and filter network; accepts any 115-v power between 50 and 400 cps and converts it to requirements of servo analyzer; is suitable for line voltage variation problems of a similar nature. Available in its own cabinet (illus.) or on panel for rack mounting.—*Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **284** on inquiry card.

REGULATED INVERTER

New "Type INV-6601-02" produces unusually high wattage per pound of weight and per cubic inch of volume. Input 24 to 30 vdc at 4.5 amp max at



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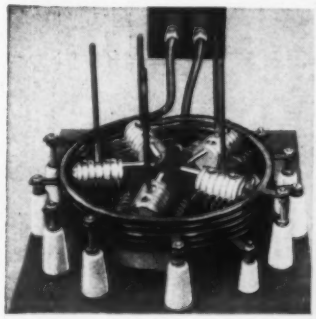
HIGH FREQUENCY *Induction* HEATING UNITS

BRAZING · SOLDERING · HARDENING · ANNEALING · BOMBARDING · MELTING

The Lepel line of Induction heating units represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating. With a background of half a century of electrical and metallurgical experience, the name Lepel has become the symbol for quality in induction heating equipment embodying the highest standards of engineering achievement, dependable low cost operation and safety.

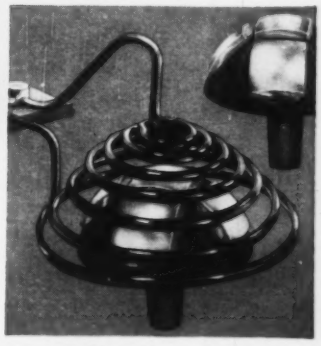
If you are interested in the application of induction heating you are invited to send samples of the work with specifications of the operations to be performed. Our engineers will process these samples and return the completed job with full data and recommendations without any cost or obligation.

TYPICAL INDUCTION HEATING APPLICATIONS



A widely used application in which several assemblies, consisting of a brass body, six radiator fins and a mounting stud, are being soldered simultaneously. The production of similar parts can be further increased by using two work coils and a change-over switch.

The illustration shows a lens grinding block being heated within the dome-shaped work coil. The heat generated in the metal block softens the pitch enabling the operator to remove the ground lenses and insert the next batch. The entire operation is completed in a few seconds.



Electronic Tube Generators—1 KW; 2½KW; 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.
Spark Gap Converters 2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.

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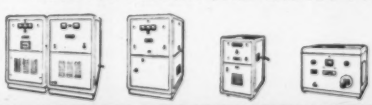

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

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For more information circle **94** on inquiry card.

Precision - Produced MATERIALS *for* TRANSISTORS and DIODES

GOLD doped with N-type or P-type elements — supplied in the form of wire, sheet or ribbon and cut or stamped pieces.

INDIUM electroplated base or precious metal wires.

WELDED RIBBONS—Dissimilar metal ribbons of the same width can be continuously welded together, within close overlap tolerances.

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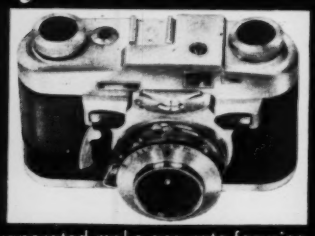
For more information circle **95** on inquiry card.

New Camera Uses Mirrors by **EVAPORATED**



In precision range finder system

Through a unique push-button system, first surface mirrors by Evaporated make accurate focusing possible in the Graphic 35mm camera. "First surface mirrors of high quality have played an important part in making the Graphic 35 number three, among 35mm cameras, in the nation," says William R. Sanderson, Chief Engineer for Graflex, Inc., Rochester, N. Y. "The rapid delivery and cooperative solution of sample and assembly problems provided by Evaporated Metal Films have proven them to be a superior supplier of these products." This same cooperative effort is available to you, too, whether your interests lie in photography, optics, instrumentation, automation, or any situation where control of light is necessary. For details of Evaporated's coatings, write for free descriptive booklet.

EVAPORATED METAL FILMS CORP.
Ithaca, New York

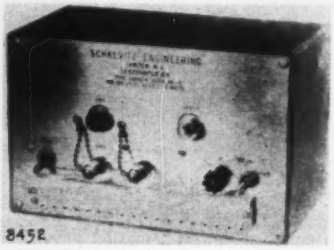
For more information circle **96** on inquiry card.

NEW INSTRUMENTS

−55°C. Ambient temperature range −55°C to 71°C. Output 115 v 400 cps single, 2- or 3-phase, 20 to 40 watts. Efficiency 40% at room ambient at 25 v; voltage and frequency regulation 5% over all conditions.—*John Oster Mfg. Co., Avionic Div., Racine, Wis.*

For more information circle **285** on inquiry card.

HIGH-GAIN SERVOAMPLIFIER



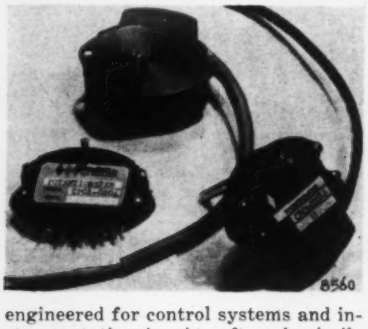
New "SA60C-4," designed to power control winding of a small two-phase motor in an LVDT-controlled servo system, is used for applications in which amplification of minute 60- or 400-cps signals is required to produce up to 4 watts of controllable power. When operated in response to displacement of core of maker's LVDT displacement pickup, it makes possible an almost unlimited variety of measurement and automatic-control applications.—*Schaevitz Engineering, P. O. Box* 505, *Camden* 1, *N. J.*

For more information circle **286** on inquiry card.

ELECTRICAL COMPONENTS

GONIOMETRIC VDRs

New "Models CP01-0103-1, CP01-0207-1 and CP01-0204-1" sector type voltage-dividing resistors, especially

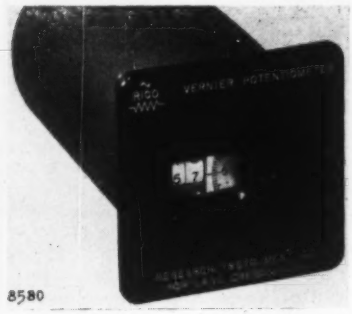


engineered for control systems and instrumentation in aircraft and missile systems, are designed to measure angles from zero to 90° of shaft rotation. Accuracy 0.5%; resolution 0.10°. High-temperature insulation withstands up to 300°F. Units meet explosion-proof requirements; severe environmental conditions, vibration, shock and temperature.—*Humphrey Inc.*, 2805 *Canon St., San Diego* 6, *Calif.*

For more information circle **287** on inquiry card.

VERNIER VDR

New "Vernier Potentiometer" is a voltage-dividing resistance device in which a single knob, pushed or pulled,



operates either of two resistance decades or interpolating resistor with simple and positive drive. Three turns of knob cover its full range. Input resistance is 10,000 ohms +0.05%; linearity 0.01%; resolution 0.002%. Other resistance ranges available.—*Research Instrument Co., PO Box* 9168, *Portland* 16, *Oregon.*

For more information circle **288** on inquiry card.

TRIMMING VDRs

New "Acetrim" subminiature precision wire-wound voltage-dividing resistor trimmers now cover 10 ohms to

150,000 ohms, with a standard linearity of 3%; are said to "offer outstanding performance characteristics and dependability in the tiniest possible size."—*Ace Electronics Associates, Inc.,* 103 *Dover St., Somerville* 44, *Mass.*

For more information circle **289** on inquiry card.

ELECTRONIC COMPONENTS

POWER RECTIFIER

New "Type CK 777" silicon power rectifier has a peak inverse rating of 325v and an average current rating of 5 amp at 125°C. Maximum reverse current at PIV of 325 is only 5 ma and maximum forward voltage drop at 10 amp is only 2.—*Raytheon Mfg. Co.,* 55 *Chapel St., Newton* 58, *Mass.*

For more information circle **290** on inquiry card.

I-F CRYSTAL FILTER

New "Part S-17976" subminiature IF crystal filter for 455 kc, designed to operate from high-mu pentode

Kearfott Components

FOR EVERY SYSTEM APPLICATION

KEARFOTT offers the systems manufacturer the most complete line of precision made components available anywhere. Quantity production enables quick deliveries and reasonable prices.

SYNCHROS—Transmitters, Control Transformers, Resolvers, Repeaters, and Differentials in Bu Ord Sizes 8, 11 and 15. High Accuracy and environmental resistance.

SERVO MOTORS—High torque, low inertia Servo Motors, Inertial and Viscous damped Servo Motors, in Bu Ord Sizes 8, 11, 15, 18 and 23.

TACHOMETER GENERATORS—Available as damping generators, rate generators and integrators. They feature high output to null ratio and extremely linear outputs. Temperature stabilization may be provided.

GYROS—Directional, floated rate integrating, free, vertical, and spring restrained rate gyros for all airborne navigation, stabilization or fire control applications.

Bulletins giving physical and technical data of the various Kearfott Products will be sent on request. The Kearfott organization is available to assist in the development and manufacture of other precision components you may require.

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For more information circle **97** on inquiry card.

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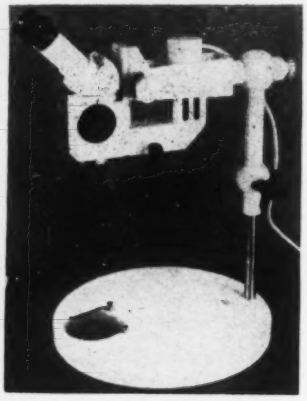
MICRO TECHNOSCOPE

A stereoscopic binocular microscope eminently suited for industrial inspections and examinations. Intense illumination parallel with line of vision. Erect, plastic image even in deep cavities.

Free working-distance of 8 inches. Magnification changing device provides rapid succession of 6.3x, 10x, 16x, 25x, and 40x magnifications.



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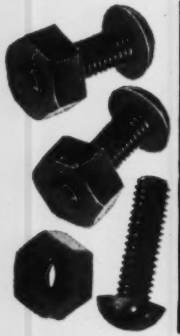

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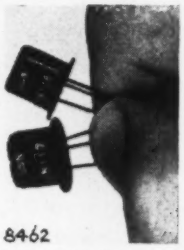
(220 kilohms) to grid, has a 9-kc wide pass band permitting its use in practically any communications or highly selective receiver with good fidelity of operation. It contains no spurious responses that could permit passage of other channels, images or harmonics. Attenuation is 50 db at a band width of less than 20 kc. Size 15/16" x 1-5/16" x 2¼" high; weight 4¼ oz. Unit is easily inserted in any interstage circuit with no other circuit modification necessary.—*Burnell & Co., Inc., 45 Warburton Ave., Yonkers, N. Y.*

For more information circle **291** on inquiry card.

SILICON TRANSISTORS



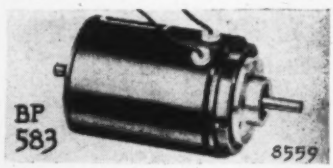
New "USN-2N117 and USN-2N118," said to be "the first two production types of silicon transistors meeting the rigid requirements of Navy specifications," are available only to manufacturers of military equipment; provide high gain in small signal applications at temperatures to 125°C; feature close parameter control. ★ Commercial versions, "2N117 and 2N118," extend all benefits ensured by Navy specs to manufacturers of commercial equipment.—*Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **292** on inquiry card.

ELECTROMECHANICAL COMPONENTS

MAGNETIC CLUTCHES

New miniature magnetic clutches are designed for electrical control of rotary mechanical functions, also as

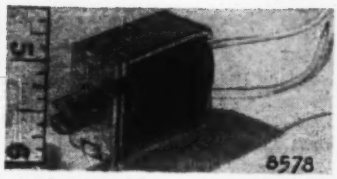


controlled loads or stops. "Model 583," 1-¼" dia and 2-⅛" long, has a maximum combined braking and clutching torque of 8 oz-in. Designed for more rugged duty, "Model 543" is 1-¾" dia and 4-⅛" long, torque 35 oz-in.—*Helipot Corp., Newport Beach, Calif.*

For more information circle **293** on inquiry card.

CUSTOM D-C SOLENOIDS

New "Series 100 and 300" can be assembled into 300 different types from 20 standard parts, so that exact requirements can be met without incurring long production lead time normally associated with design and



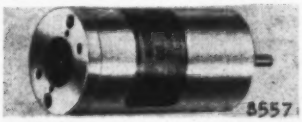
manufacture. New units feature light weight, maximum power-to-size ratio; plungers designed for push or pull; wide variety of mountings, coils and wire sizes. Illustrated is "Model SO-151" with 1500-ohm coil wound on molded nylon bobbin; stroke from 1/32" to 1/4"; 9-oz pull with 3/16" stroke @110 vdc; weight 2.6 oz.—*Joseph Pollak Corp., 81 Freeport St., Boston 22, Mass.*

For more information circle **294** on inquiry card.

MOTORS, etc.

MINIATURE DC MOTORS OR GENERATORS

New dc motors or MGs are 0.875" dia., 1.625" long, 0.098" shaft dia; feature self-aligning sleeve bearings



with Nylon retainer (ball bearings optional); hardened, ground and lapped shaft; Alnico TV ring type stator; adjustable brush bracket. Units of other diameters and lengths are also available.—*Heinz Mueller Engineering Co., 1906 N. Cicero Ave., Chicago 39, Ill.*

For more information circle **295** on inquiry card.

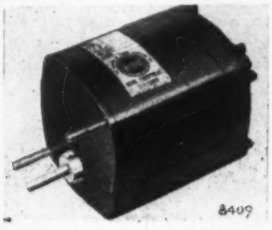
FRACTIONAL HP MOTORS

"New "application-engineered" 1/300 to 1/4 and 1/3 hp electric motors are special motors, "with cost and delivery comparable to 'standard' units." Maker's "pre-selection" system applies to series-wound, shunt-wound, shaded-pole and permanent-magnet motors and gear-motors, 2 to 230 v ac or dc. —*R. A. Boehm Co., 58 Brooklyn Ave., Merrick, L. I., N. Y.*

For more information circle **296** on inquiry card.

SUBFRACTIONAL HP MOTORS

New improved motors for precision instruments range from 1/2000 to 1/750 hp, in synchronous and induction types, with or without gear trains. Among features: End bells and gear train cases of die-cast alloys precision



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A NEW HIGH TEMPERATURE addition to the famous SPIRALPOT family of infinite resolution potentiometers... rated to deliver full power in temperature environments of 150°C. The use of special materials and alloys has *increased* the temperature range of earlier SPIRALPOT models by 80°C with *no decrease* in power rating.

Designed for use in high resolution servo systems, the Model 85177 HI-TEMP SPIRALPOT finds applications in installations requiring a potentiometer of infinite resolution and excellent linearity at elevated temperatures.

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POWER .15 watt per turn throughout operating temperature range.
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INFINITE RESOLUTION
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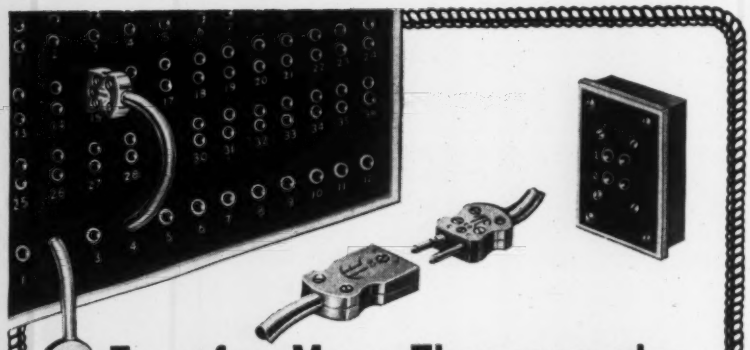
For more information circle **101** on inquiry card.



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Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multi-point recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

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Write for Bulletin 23—F.

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada—THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **102** on inquiry card.

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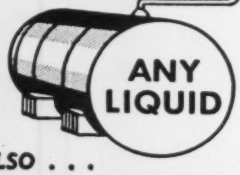

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For more information circle **104** on inquiry card.

NEW INSTRUMENTS

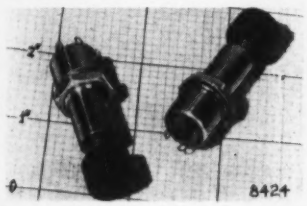
machined to form a totally-enclosed housing; all gears precision hobbed; die-cast rotors mounted on ball bearings.—*Borg Equipment Div., Geo. W. Borg Corp., Janesville, Wis.*

For more information circle **297** on inquiry card.

SWITCHES & RELAYS

PUSHBUTTON SWITCH

New "Type B 5023" pushbutton switch for computers, calculators, etc., using whole banks of adding machine-

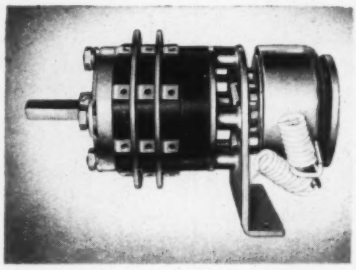


type key switches is a momentary-contact switch featuring a smooth non-snap action that closely approaches the "feel" of mechanical-type push-buttons long used on calculating machines.—*Hetherington Inc., 1200 Elmwood Ave., Sharon Hill, Penna.*

For more information circle **298** on inquiry card.

SOLENOID-OPERATED ROTARY SWITCHES

New heavy-duty rotary multipole switches are assembled with solenoid rotating devices for driving switch

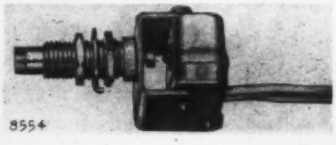


through cycle of contact positions to provide remote automatic or semi-automatic control of a series of complex circuits; are custom-built to user specs.—*Electro Switch Corp., Weymouth 88, Mass.*

For more information circle **299** on inquiry card.

SEALED SWITCH

New "No. 9129" hermetically-sealed potted switch complete with actuator operates under "the most trying environmental extremes." Special feature: threaded actuator plun-

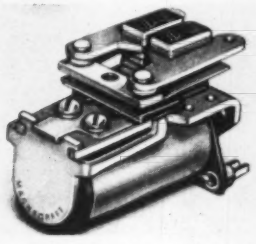


ger guide sleeve permits mounting switch actuator button flush or extended any distance from mounting board up to ⅞". Switches tested have passed 50-*G* shock MIL specification. Actuator button elastomer will flex satisfactorily at minus 90° as well as at 285°F. Switch is bonded to switch-cover and will withstand 100 psi pressure differential inside to outside without rupture or leak.—*Haydon Switch Inc., Waterbury, Conn.*

For more information circle **300** on inquiry card.

HEAVY CURRENT RELAY

New "Class 22D" telephone type relay is 2-1/16" long, features specially-designed double-break contacts



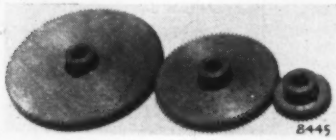
that switch up to 20 amp non-inductive load. Contacts are sp-st, normally-open. Available for operating voltages to 230 dc and 440 ac.—*Magnecraft Electric Co., 3350L W. Grand Ave., Chicago 51, Ill.*

For more information circle **301** on inquiry card.

MECHANICAL COMPONENTS

LINEN PHENOLIC SPUR GEARS

New "Type AB" precision linen phenolic spur gears are immediately available from stock in a wide varity

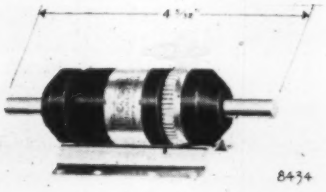


of variable pitches: are cut and stocked to AGMA standards Prec. 1. Material is to MIL-P-15035 Type FBL.—*PIC Design Corp., 160 Atlantic Ave., Lynbrook, L.I., N. Y.*

For more information circle **302** on inquiry card.

MINIATURE DIFFERENTIALS

New miniature differentials are easily installed because they have ball-bearing shaft supports that are



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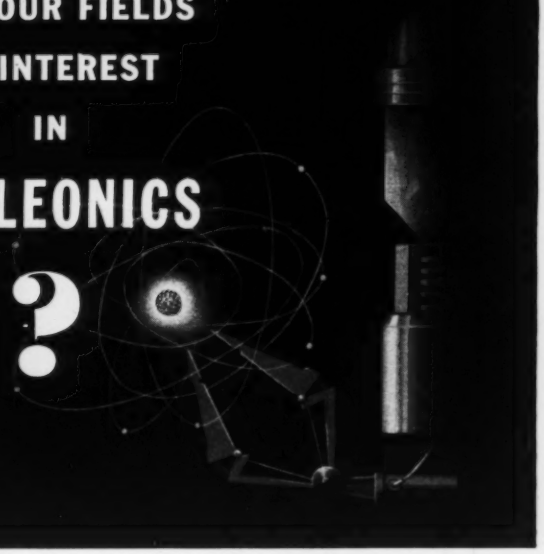

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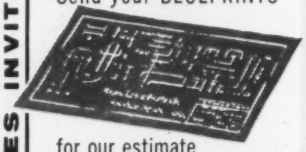

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For more information circle **106** on inquiry card.

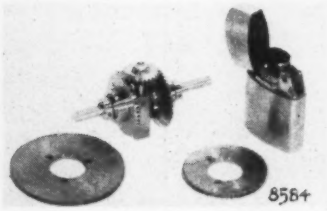
NEW INSTRUMENTS

mounted. Thirty-four ratios from 1:1 to 27:1. Backlash between in-line shafts is 4° or less measured at low-speed shaft with large external gear held stationary.—*Metron Instrument Co., 432 Lincoln St., Denver 3, Colo.*

For more information circle **303** on inquiry card.

DIFFERENTIAL

New "Servoboard" differential features "Coneflex" gears and double ball bearings to assure low breakaway



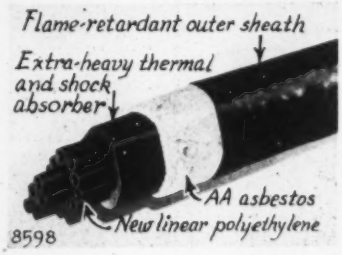
torque and minimal backlash. End gears are removable to provide flexibility in achieving various gear ratios. Four such stainless steel gears are available to provide seven ratios from 1/1 to 1/1.666. All gears have a 14½° pitch angle and 48 diameter pitch.—*Servo Corporation of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.*

For more information circle **304** on inquiry card.

TUBES, FITTINGS, etc.

TWELVE-TUBE HARNESS

New "Dekoron Super Poly-Cor" fire- and impact-resistant instrument-line harness can be used in hazard-

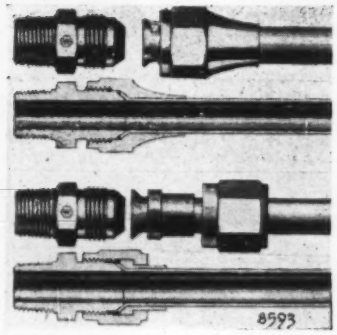


ous areas or can be buried in the ground. Said to be "unique in both design and materials of construction" (see illustration), it is installed in the same manner as standard "Poly-Cor" or "Metl-Cor." It is available in increments of 100 ft or in 500-ft coils of twelve ¼" OD tubes.—*Samuel Moore & Co., Mantua, Ohio.*

For more information circle **305** on inquiry card.

STRAIGHT-THREAD FITTINGS

New straight-thread type fittings have been added to "Flare-Twin" line of SAE 37° flared J.I.C. steel tube fittings which offers a choice of 3-piece and 2-piece types in different styles and sizes. These new straight-thread type fittings come in popular



styles and sizes for use with new SAE-approved O-ring boss design; withstand higher operating pressures without use of backup rings. Other advantages: easier assembly; minimum close coupling; less O-ring distortion; longer O-ring life; can be repeatedly disassembled and reassembled without affecting seal.—*Weatherhead Co., Fort Wayne Div., 128 W. Washington, Fort Wayne, Ind.*

For more information circle **306** on inquiry card.

VALVES

FULLY-ADJUSTABLE SOLENOID VALVE

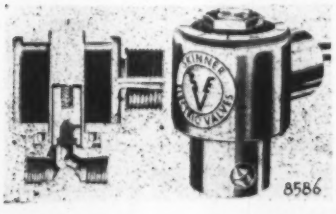
New "Type HV" is said to be "the first solenoid valve to provide independent controls for manual opening,

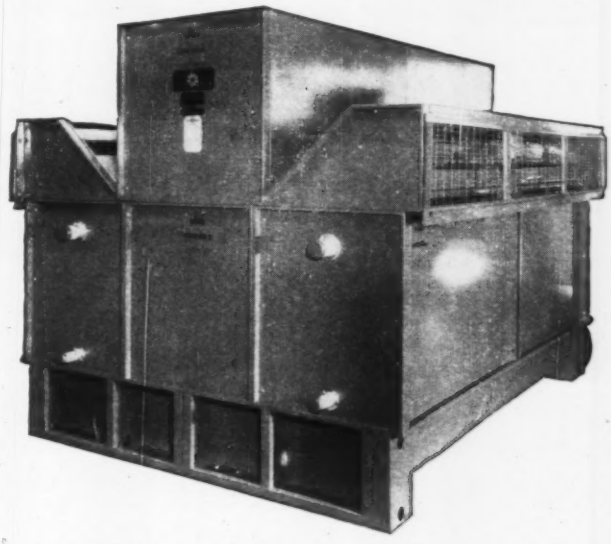
and adjustment of flow, opening and closing speed." Other features include packless design, unbreakable piston rings, full ports and non-shock closing, and coils guaranteed unconditionally for one year. Sizes ½" to 2"; present maximum 300 psi.—*J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis 18, Ind.*

For more information circle **307** on inquiry card.

SOLENOID VALVE

New "C Series" brass-body ⅛" NPT low-cost solenoid valve for control of air, water, oils, gasoline and many other fluids and gases weighs 12 oz; is a packless direct-acting





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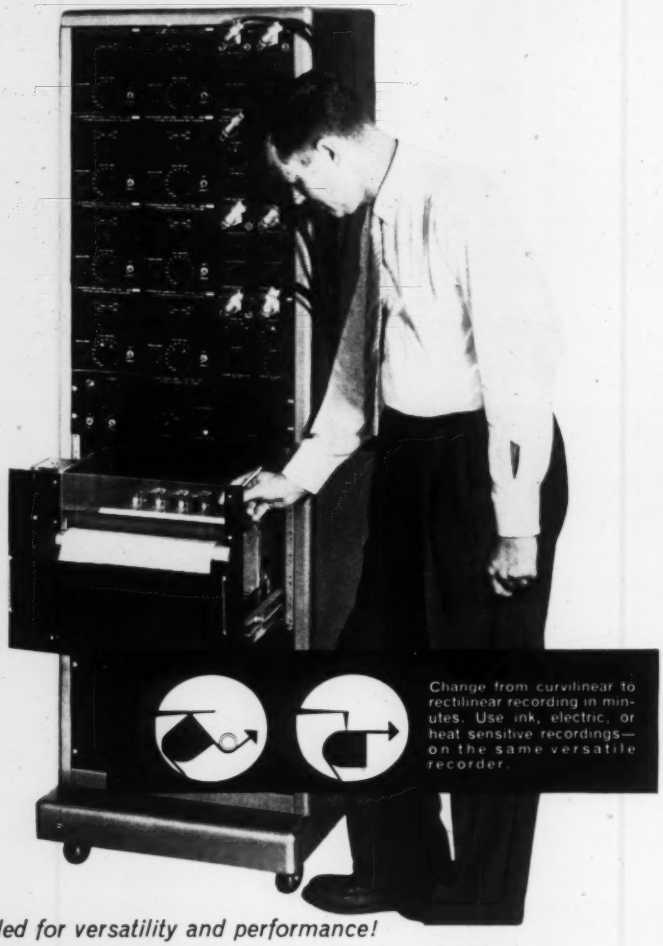
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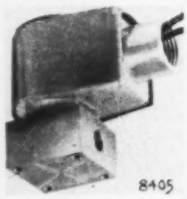
For more information circle **108** on inquiry card.

valve, with only two moving parts; positive closing assured by spring return. Maker claims this valve to be bubble-tight, even on vacuum, and that valve will last through millions of cycles on most applications. *—Skinner Electric Valve Div., Skinner Chuck Co., New Britain, Conn.*

For more information circle **308** on inquiry card.

SHUT-OFF SOLENOID VALVE

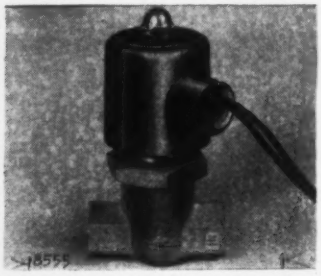


New "Bulletin 8264" two-way solenoid valve for cooling applications using liquid Co_2 is available in two types of construction: (1) direct injection valve which obviates need for piping and reduced orifice on outlet side of valve; (2) remote injection valves provided with ⅛" inlet and outlet pipe connections for remote valve location. Valves have stainless steel angle type bar stock bodies and Teflon discs for tight shut-off on pressures to 1,000 psi.—*Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.*

For more information circle **309** on inquiry card.

SOLENOID VALVE

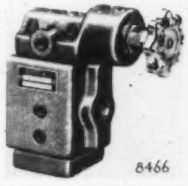
New "Series 2101 Electroflo" solenoid valve for air pressures up to 100 ps. can be secured with a full ⅜" or



¾" orifice. Continuous duty solenoids are availabie from 6 vdc to 440 vac. Over-all length of ⅜" valve is 2 17/32"; of ¾" valve, 3 ¾".—*Dept. No. 316A, Hays Mfg. Co., West 12th St., Erie, Penna.*

For more information circle **310** on inquiry card.

REDUCING VALVES



Two new low-pressure type pressure reducing valves for industrial oil-hydraulic systems can provide any controlled reduced outlet pressure from 25 to 1000 psi, in systems having operating pressures up to 2000 psi. "Model XGL-03-B" is a gasket mounted design; "Model XTL-03-B" (illustrated)

precision

PRESSURE REGULATORS

14 models to meet almost all industrial needs

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Now available from the Stratos Industrial Products Branch are two complementary lines of pneumatic pressure regulating valves.

The pilot-operated GOVERNAIRE: very high flows are regulated by small signals in these self-contained, pilot operated models. Up to 250 psi supply pressure, pipe sizes from ¼ to ¾ NPT.

Drift-free, lever set model 3500

The direct acting KENDALL: also available in a wide flow range, these force-balanced types are designed for operation at up to 250 psi supply pressure. Pipe sizes from ¼ to ¾ NPT.

STRATOS

INDUSTRIAL PRODUCTS BRANCH

A division of Fairchild Engine and Airplane Corp.

Route 109, West Babylon, N. Y.

For more information circle **109** on inquiry card.

is provided with ⅜" pipe thread connections. Both models are nominally rated at 8 gpm flow capacity. Free reverse flow is allowable, provided pressure at reduced pressure port does not exceed reduced pressure setting of the valve.—*Vickers Inc., Box 302, Detroit 32, Mich.*

For more information circle **311** on inquiry card.

FOUR-WAY AIR VALVE

Three new 4-way models are added to "Allenair" line of ¼", ⅜" and ½" air valves; are available as single

solenoid, or for foot or cam operation. Single solenoid valves are air-return, no springs used in their construction. All friction surfaces are hardened and permanently coated with a baked-on lubricant. All valves are designed for operation from 5 to 150 psi; solenoid valves can reciprocate at 800 strokes per minute. Two speed controls are built-in to provide full control of cylinder piston in both directions.—*The A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.*

For more information circle **312** on inquiry card.

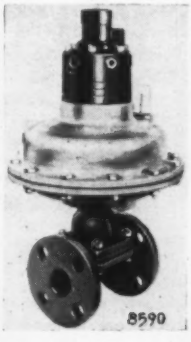
AIR VALVE

New 1½" 4-way valve for 0 to 250 psi service incorporates "Shear-Seal" pressure-balanced self-aligning tubular sealing ring in constant contact with an optically flat porting disc or rotor containing flow passage. Non-corrosive materials are used for all valve parts.—*Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.*

For more information circle **313** on inquiry card.

SAUNDERS-TYPE VALVES

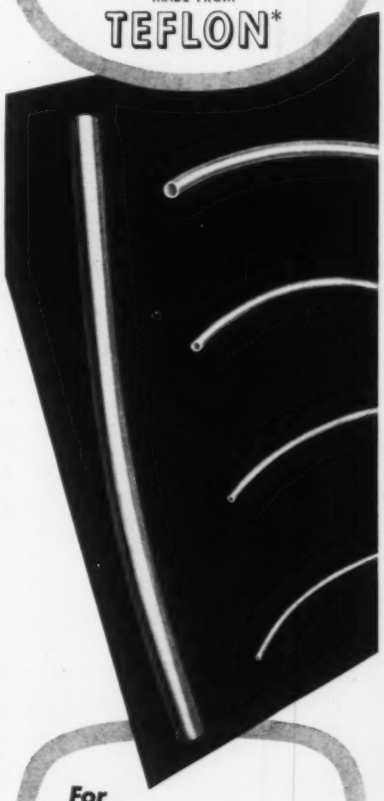
New line of air-operated Saunders Patent type control valves, for the water treating, chemical, and process industries, is said to be complete. Main features: no stem packing or stuffing box; tight shut-off; no clogging or sticking. Optional features include hand-



INSTRUMENT TUBING

MADE FROM

TEFLON*



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- **extreme temperature service range (-450°F to +500°F)**
- **chemically inert**
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- **rinses clean and does not contaminate**

PF instrument tubing is stress relieved for minimum shrinkage and carefully inspected and controlled dimensionally. A full range of sizes and colors are available to meet your specific needs. Write, wire or call for further information, competent engineering assistance and information on special sizes and walls. PF flexible tubing, heavy-walled tubing and rod stock made from Teflon* is also available.

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*"Teflon"—Du Pont trade name for Tetrafluoroethylene resin

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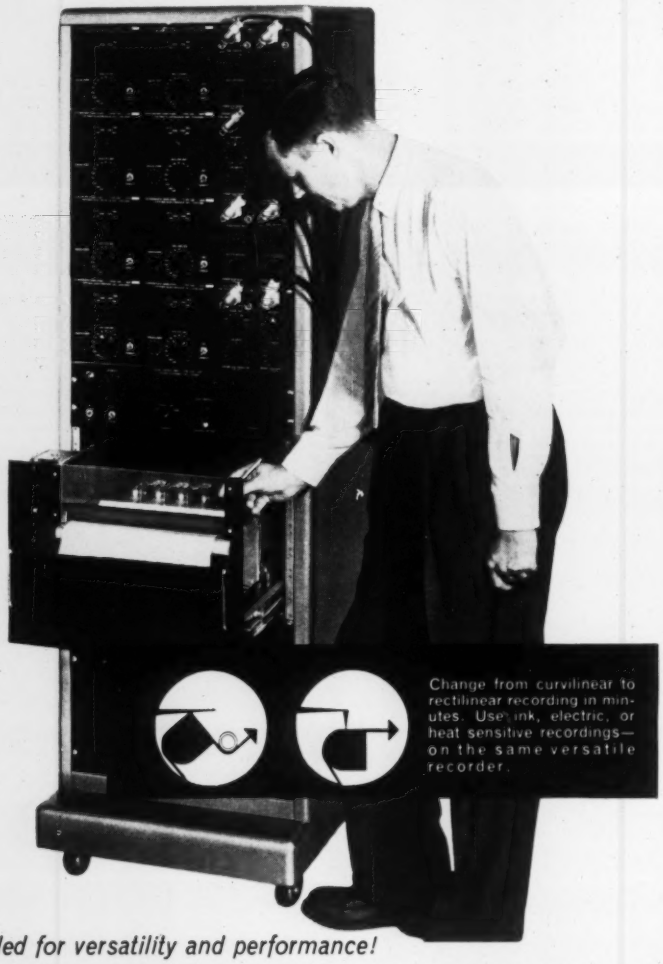
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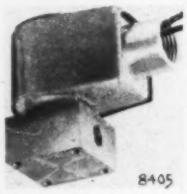

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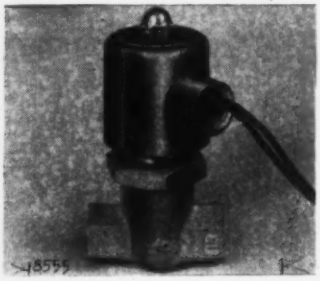

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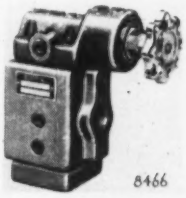

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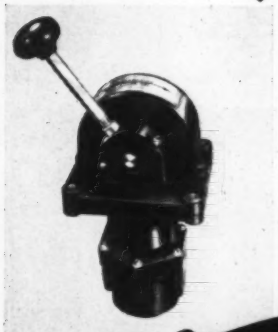

Drift-free, lever set model 3500

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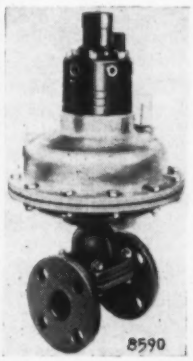

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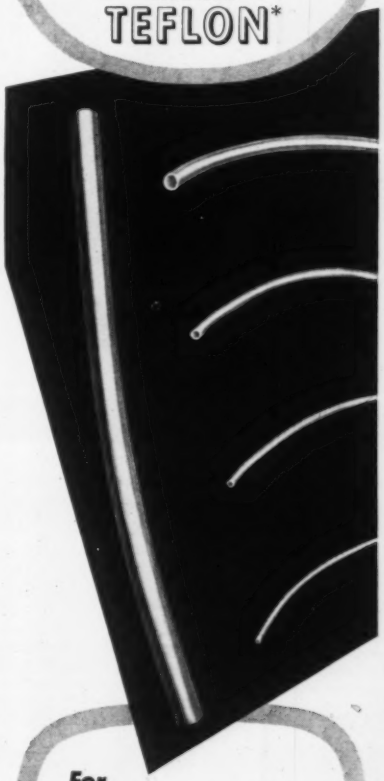

For

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- **extreme temperature service range (-450°F to +500°F)**
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*"Teflon"—Du Pont trade name for Tetrafluoroethylene resin

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30 to 20,000 cycles per second

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The instrument measures phase difference between two sinusoidal voltages; phase angles are read from a two-degree, step control with vernier indicator having a precision of 0.01°. Built-in sensing provides direct reading of proper quadrant. Accuracy is independent of even harmonics and of third harmonics up to 1%. Input-level range is from 0.5 to 10 volts rms.

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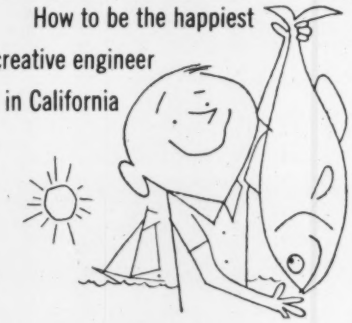

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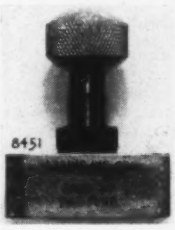
NEW INSTRUMENTS

wheel type limit stops, plastic position indicators, Micro switch attachments, etc. Various body materials, body linings, and valve diaphragm materials; springless, close-coupled, or spring type; sizes ½" to 6".—*Uniflow Valve Corp., 19 Quine St., Cranford, N. J.*

For more information circle **314** on inquiry card.

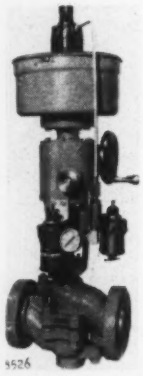
INSTRUMENT VALVE



New "INS" valve, featuring positive non-leak shut-off, "O" ring seals and plastic self-extracting seat, operates from vacuum to 3000 psi with finger tip control at all pressures. No over-torque damage to needle or seat. No metal-to-metal contact. Complete overhaul without disturbing plumbing or mounting.—*Robbins Aviation, 1735 W. Florence Ave., Los Angeles 47, Calif.*

For more information circle **315** on inquiry card.

HANDWHEEL OPERATOR



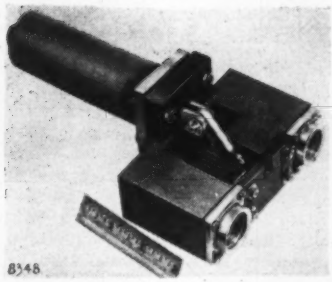
New "Cono-Clutch," available as an integrally mounted accessory for "Cylinder Conomotor" pneumatically positioned power actuators, affords immediate manual control in event of air failure; is the only operator of its type which can be instantly thrown in and out of gear at any position of stem travel. No special tools required. When handwheel is in declutch position, there is no interference with full and free stem travel.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa.*

For more information circle **316** on inquiry card.

FOR AIRCRAFT AND MISSILES

HI FLOW PROPELLANT VALVE

New pressure-operated multi-line propellant valves have been designed and service-tested for high-performance airborne missile and rocket applications, as well as ground test installations. Among features: Exclusive floating ball-seat valve arrangement provides zero leakage under all conditions; unobstructed, straight-through design for zero relative pressure drop; linked multi-line design provides 2-line or 3-line control func-

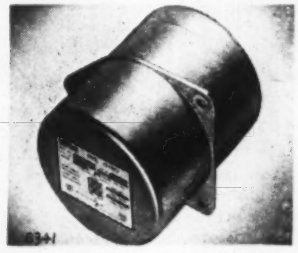


tions for any line size combinations from ½" to 4"; piston type actuator accepts any gas or fluid medium; can operate with input actuation pressures from 200 psi to 3000 psi.—*Hydromatics Inc., Cedar Grove, N. J.*

For more information circle **317** on inquiry card.

FREE GYRO

New "Model 3416" is said to offer unusual ruggedness and insensibility to mounting and dynamic loads. Shock



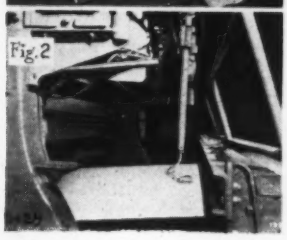
specification is 50 *G* in all axes; drift rate is less than 18 minutes of arc per minute; outputs up to 70 v with linearity of ±0.5% and resolution of 0.09°.—*G. M. Giannini & Co., Inc.* 918 *E. Green St., Pasadena* 1, *Calif.*

For more information circle **318** on inquiry card.

MISCELLANEOUS

PAPER MOISTURE METERS

New "Aquatel" moisture measuring equipment is available in lab model (Fig. 1) and continuous scanning unit (Fig. 2) for automatic control. System uses electrical conduc-



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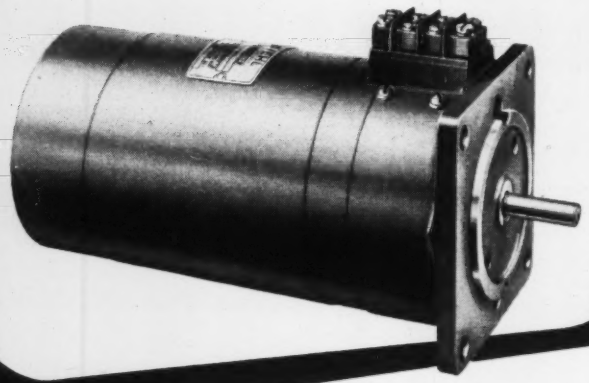
THE NEW

DIEHL

ULTRALINEAR DC TACHOMETER GENERATOR

A computing element of great accuracy



Linearity of this tachometer is within 0.02% expressed as a percentage of the output voltage at any speed from near zero to 4000 rpm. Unique design features maintain ripple voltages between 100 rpm and 4000 rpm at less than 0.04% of the output voltage and the magnitude of the ripple voltage decreases appreciably at speeds below 100 rpm.

Note these specifications:

Output Voltage (volt/1000 rpm)	8.75
Linearity (percent)	0.02
Maximum Speed (rpm)	4000.
Armature Inertia (oz. in.^{2})	3.7
Friction Torque (oz. in.)	1.
Weight (lbs.)	8.

Diehl

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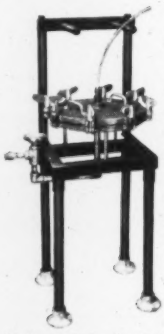
For more information circle **114** on inquiry card.

tivity of paper when an alternating voltage is applied to it. Resultant signal is fed into a bridge circuit in which capacitances of sample and measuring system cancel out. An attenuator section allows compensation for temperature, various types of furnishes and basis weight variations. Range 3-10% moisture content; attainable accuracy 0.25%.—*Isotope Products, Inc.*, 1711A *Elmwood Ave., Buffalo, N. Y.*

For more information circle **319** on inquiry card.

WATER FILTER



New "MF Submicron Filter" uses a new ultra-fine method of water filtration; filters out particles as small as 0.000016". Filtering element consists of a cellulose ester disc about 150 microns thick with total pore volume of 80 to 85%. Operating pressure drop across a clean filter disc is less than 0.3 psi at flow rate of 100 gph. Element provides quantitative retention of all particles larger than 0.45 micron suspended in water at temperature under 200°F. Bacteria are removed.—*Barnstead Still & Demineralizer Co.*, 157 *Lanesville Terrace, Boston* 31, *Mass.*

For more information circle **320** on inquiry card.

PORTABLE pH RECORDER

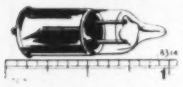
New self-contained, pH instrumentation, for field surveys of stream pollution (illus.), waste-treatment

plant effluent, and industrial water supplies (as well as in-plant studies at locations where a permanently mounted pH recorder is not desired or where power is not available) comprises two units: a Bristol "Model 524" pH recorder and a Beckman "N-2" amplifier; covers total pH range of 0-14 in two spans of 0-8 and 6-14. Chart drive can be set for 1-hour or 24-hour rotation.—*The Bristol Company, Waterbury* 20, *Conn.*

For more information circle **321** on inquiry card.

SUBMINIATURE NEON LAMP

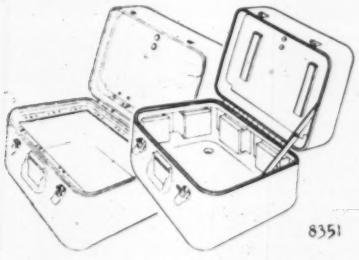
New "NE2C," designed with a midget flanged base and interchangeable in many assemblies with existing miniature aircraft lamps of No. 327 to 338 series, is much smaller than based neon lamps heretofore available; is suitable for a wide variety of indicator and computer applications. Power consumption is infinitesimal (0.04 watt). Average life over 25,000 hours. Starting voltage 65 vac.—*Circon Component Co., Santa Barbara Municipal Airport, Goleta, Calif.*



For more information circle **322** on inquiry card.

INSTRUMENT CASES

New standard line of drawn aluminum instrument cases meets MIL-T-945A and MIL-STD-108c; includes

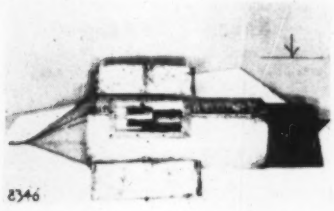


transit, combination and instrument-case types in various sizes; provides savings in time and cost over production of equivalent special or custom-built cases.—*Instrument Cases Inc., 510 W. Garfield St., Glendale 4, Calif.*

For more information circle **323** on inquiry card.

DEPTH-SEEKING FLOAT

New water-pressure-actuated float can be set to maintain a given depth below surface. When towed by a fish-



ing boat, it will keep nets at desired level. Also excellently suitable for hydrographic surveys, naval mine sweeping, underwater construction, etc.—*John A. Hinckley and Associates, Inc., 10316 S. Throop St., Chicago 43, Ill.*

For more information circle **324** on inquiry card.

RUGGEDIZED TV CAMERA AND ACOUSTICAL HOUSING

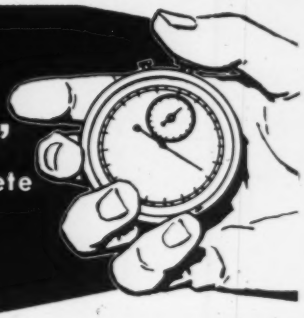
New "Model 1985 CN" ruggedized camera and new "Model ACH-6" acoustical housing make it possible for industrial television cameras to operate properly under high ambient

now...

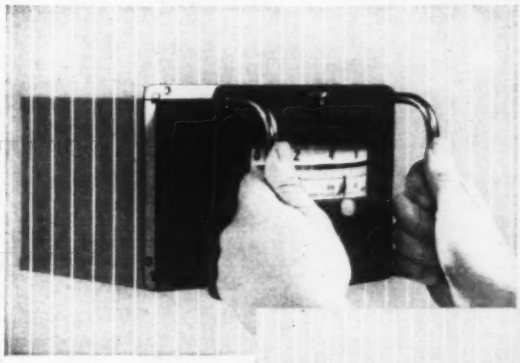
THE TRUE "PLUG-IN"

seconds to exchange complete temperature control units

by **WEST**

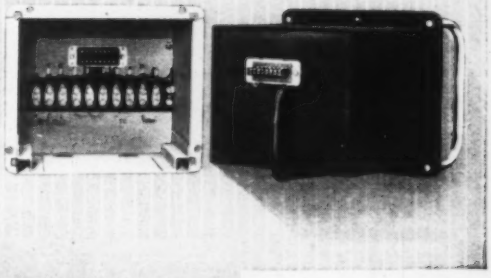


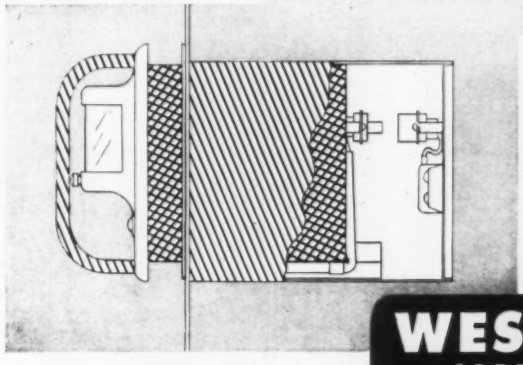
Ideal for modern *continuous* operations; *Perfect* for round the clock shift *maintenance*. *Eliminates down time!* Available for all types of West Instruments—On-Off, Stepless, Proportioning, etc. New, or supplied as modification kit for instruments in use.



No tools needed; no control loss

Built-in plug, automatic alignment





May be flush or surface mounted

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For more information circle **116** on inquiry card.

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661 U. S. Highway 22 Hillside, N. J.

For more information circle **117** on inquiry card.

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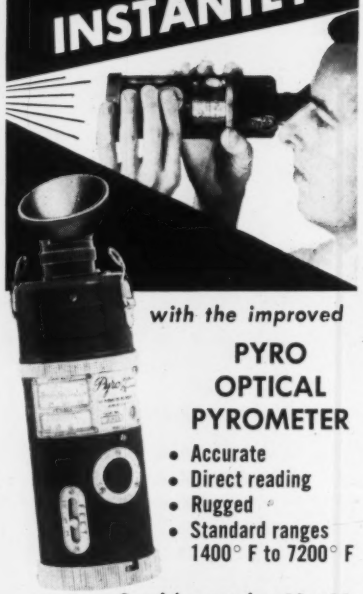

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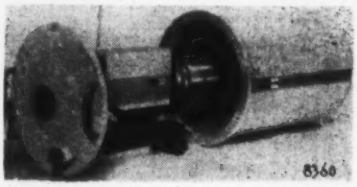
- **Rugged**
- **Standard ranges 1400° F to 7200° F**

Send for catalog No. 85.

PYROMETER INSTRUMENT CO., INC.
BERGENFIELD 4, NEW JERSEY

For more information circle **118** on inquiry card.

NEW INSTRUMENTS

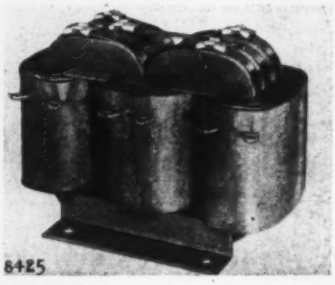


noise conditions (previously impossible). Idealy suited for rocket and jet engine test facilities, rocket launching sites, etc.—*Kay Lab* 5725 *Kearny Villa Road, San Diego* 11, *Calif.*

For more information circle **325** on inquiry card.

SATURABLE REACTORS

New complete line of saturable reactors, from 0.3 to 500 kva, for manual or automatic control of power,



provides stepless control under command of a dc signal. Available enclosed or open. Each reactor is tested to meet or exceed NEMA Standards. —*Hevi-Duty Electric Co., Milwaukee* 1, *Wis.*

For more information circle **326** on inquiry card.

VERSATILE REFRACTOMETER

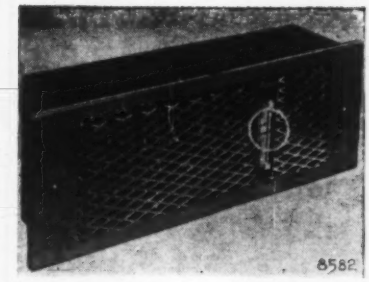
New low-cost "Goldberg Combination Hand and Dipping Refractometer," for precise and rapid determi-

nation of total soluble solids in food products, is available in two models: Brix ranges 0 to 47% or 45% to 75% soluble solids. A thermometer recessed in prism mounting increases accuracy by measuring temperature of sample rather than of ambient air. Leather case.—*American Optical Co., Instrument Div., Buffalo* 15, *N. Y.*

For more information circle **327** on inquiry card.

COOLING PANEL

New cooling panel for standard 19" enclosed relay racks has built-in fan to pull air through a 2" thick fiber-



glass dust-filter on which there is a novel "Filter Pilot" (white circle) to indicate when filter replacement is due. Panel can handle 2000-watt dissipation with a 40F° rise.—*Rotron Mfg. Co., Schoonmaker Lane, Woodstock, New York.*

For more information circle **328** on inquiry card.

GAS PURIFIER-DRYER

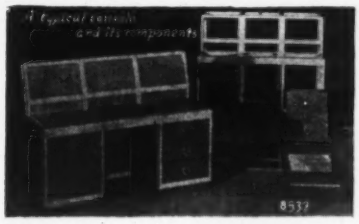
New "Deoxo Puridryer MS" is a gas purifying and drying unit incorporating catalytic purifying with reactivating-type dryers in one assembly for the first time. It employs a Linde molecular sieve in place of previously used activated alumina to register gas dew-point readings of better than −100°F. In a typical application, it feeds dry oxygen-free hydrogen (less than 1 part oxygen per million parts hydrogen) into an atmospheric furnace at a maximum rate of 100 cfh.—*Baker & Co., Inc., 113 Astor St., Newark 5, N. J.*

For more information circle **329** on inquiry card.

CABINETS, CONSOLES, ETC.

New method permits selecting from 75 mass-produced building-block metal cabinet enclosures and 125 different

sub-parts to provide infinite varieties of cabinets to house measuring, testing, and automatic control equip-



ment. It is said that "one of the more elaborate consoles, factory sub-assembled from 30 component modules, sells for $600; a comparable custom-built model would cost over $1,500."—*Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill.*

For more information circle **330** on inquiry card.

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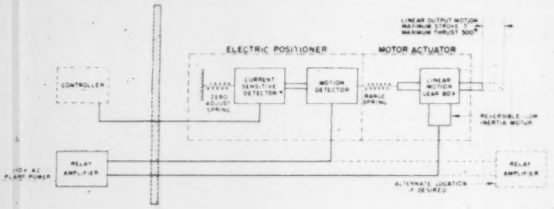
INSTRUMENTS and AUTOMATION Briefs

For this literature circle number on inquiry card.

Electric Valve Actuator

The Series "D" Electric Valve Actuator uses the time accepted force-balance principle in the positioner feedback system . . . Motion of the vertical output shaft is fed back to the current-sensitive detector in the positioner by means of a small range spring. When the stem reaches the position dictated by the instrument controller, the force developed by the range spring equals the force of

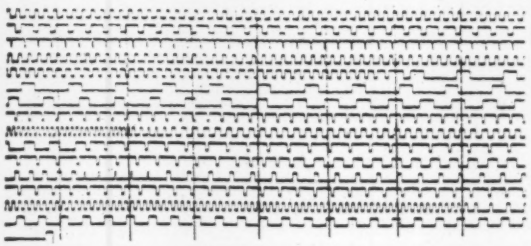


the current-sensitive detector, and the system comes to balance with the driving motor remaining at rest . . . The entire system is sensitive to ½of 1% of controller signal span and has a repositioning accuracy of at least ½ of 1% of stem travel. It has a rated output of 500 lbs. of thrust with a stem speed of 4" per minute . . . (*From new 2-page Bulletin D-1, Conoflow Corp., 2100 Arch St., Phila. 3, Pa.*)

For this literature circle **401** on inquiry card.

Operations Recorder

This is a drumtype operations-recorder with very slightly spiral tracing to give drum rotation at various speeds as ordered, 400 linear inches on an easily filed chart . . .

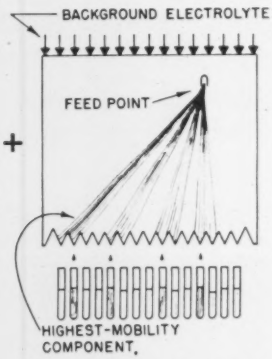


Stylus moves up uniformly ⅛" with each drum rotation. On 24-hour rotation, any given instant of corresponding days is instantly comparable since all are lined up vertically. Transparent housing permits continuous tamperproof observation of the tracing . . . Chart of tough colored paper, overlaid (not impregnated) with pure white opaque wax crystals. Stylus makes crystals transparent . . . (*From New 2-page Bulletin MD-JR-56, Gorrell & Gorrell, Haworth, N. J.*)

For this literature circle **403** on inquiry card.

Curtain Electrophoresis

Briefly, curtain electrophoresis works this way: Background electrolyte flows down a paper sheet to which a multi-component sample is fed continuously. Direct current is applied horizontally across the curtain as indicated by the symbols. The resulting electrical field de-



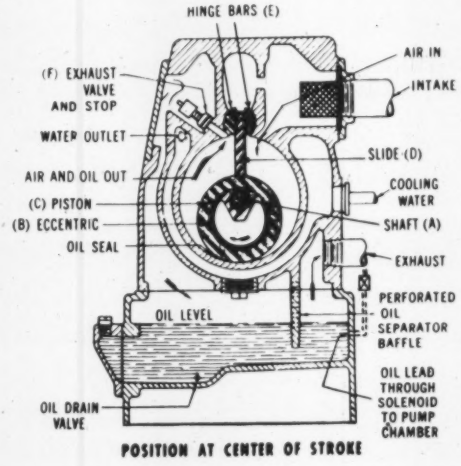
flects each component in proportion to its mobility under the particular conditions imposed. Thus, each mobility class seeks a unique path toward the bottom of the sheet . . . (*From new 4-page Bulletin SBCP-1, Beckman Instruments, Inc., Spinco Div., Belmont, Calif.*)

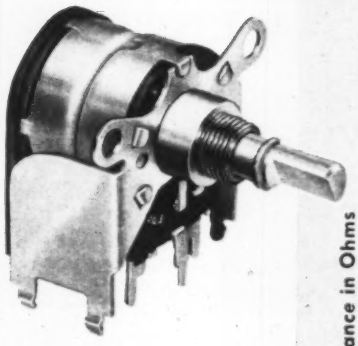
For this literature circle **402** on inquiry card.

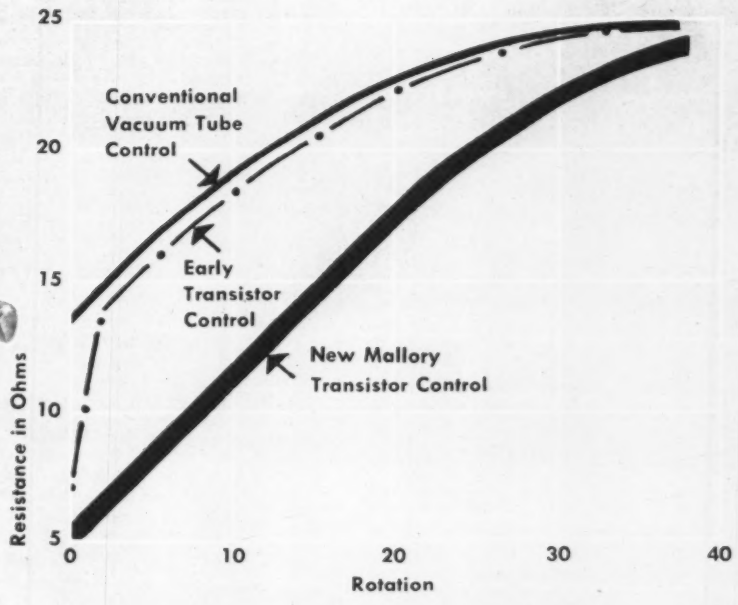
High Vacuum

Common industrial applications fall in the following categories: low vacuum, 0 to 29.5" of mercury below atmospheric pressure, referred to a 30" barometer; high vacuum, 10 mm. to 0.1 micron mercury column absolute pressure; and ultra-high vacuum, 10^{-4} to 10^{-8} mm. mercury absolute pressure . . .

As the piston revolves it acts briefly as a valve which







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Now...

A Control with Low-end Taper Especially Designed for Transistor Circuits

A new Mallory volume control, created specifically for use with transistors, provides characteristics not previously available to designers.

Low "hop-off" or zero rotation resistance
gives exceptionally low minimum volume level in low impedance circuits . . . permits full turn-down of volume level.

Special "low-end" taper
Starting from the "hop-off" value, resistance rises gradually through the first 20 to 30 degrees of rotation . . . thus providing smooth control of transistor circuit volume throughout the entire volume range.

Printed circuit design
Several models of the new control are available for use in printed circuits, for mounting vertical to or horizontal to the printed circuit panel.

Push-pull switch*
Available on all models . . . new Mallory push-pull line switch. Conventional rotary action switches can also be supplied with these new "low-end" taper controls.

Each sample control is supplied with a tag on which are given its overall resistance-rotation curve, plus a new "low-end" curve showing detailed resistance characteristics in the minimum volume range. Write to Mallory today for a sample in the resistance value, taper and mounting arrangement that you are considering for new designs . . . and for a consultation by Mallory control specialists on your particular requirements.

Expect more . . . get more from

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For more information circle **119** on inquiry card.

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Counters on the Hycon digital voltmeter and the Hycon digital ratiometer, previously driven by aircraft-type servo motors, are now powered by Barber-Colman type BYAE high-torque, low-inertia motors at a fraction of the former cost. And operating performance has been equaled or improved by this change. For accurate actuation of your products, too, there is a wide selection of Barber-Colman motors up to 1/20 hp. Unidirectional, synchronous and reversible . . . with or without gearing . . . open or enclosed. Write for Catalog F-4271-6.

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For more information circle **121** on inquiry card.

closes this inlet port from the vacuum system and traps ahead of itself all air which has entered. As the piston continues its rotation around the drive shaft and moves to the bottom of the chamber, the slide D, attached to the piston, slides down through the hinge bars E which oscillate in the pump body. Thus all new entering air is confined behind the piston and the slide . . . Air is never completely exhausted from a vacuum system. Still, a vacuum pump removes so much air that there is practically none left. For example, if we assume a closed chamber 200 feet square and 60 feet high (2,400,000 cubic feet) exhausted to a vacuum of 1 micron (10^{-3} mm. Hg) there would be left in it only the equivalent of 3 cubic feet of air at atmospheric pressure. This would be 99.99992% pure vacuum! . . . (*From new 18-page Catalog 752, F. J. Stokes Corp., Phila., Pa.*)

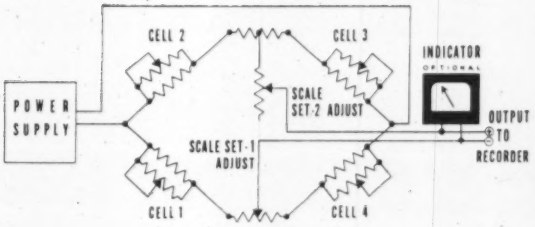
For this literature circle **404** on inquiry card.

Thermal Conductivity of Gases

No two gases have the same thermal conductivity and a mixture of two gases will usually have a conductivity between the conductivity of the two individual gases . . . A measure of conductivity may be used to indicate the ratio of gases in a binary mixture.

The thermal conductivity analyzer operates by flowing the sample gas into a set of cells designed to make a continuous measurement of the rate of heat conductance through the sample . . . Heat is lost from the filament by radiation . . . by convection . . . and by conduction of heat through the gas . . . The effect of radiation is small . . . the convective heat transfer is minimized . . . Thus, the principal means of losing heat from the filament is the thermal conductivity of the gas in the cavity . . . If the resistance of the filament in the "sample" cell is com-

For more information circle **122** on inquiry card.



pared to the resistance of the filament in another cell filled with a gas of known conductivity (reference cell), then the conductivity of the gas in the "sample" cell can be measured . . . (*From new 16-page Bulletin TD-507, Arnold O. Beckman, Inc., 1020 Mission Street, South Pasadena, Calif.*)

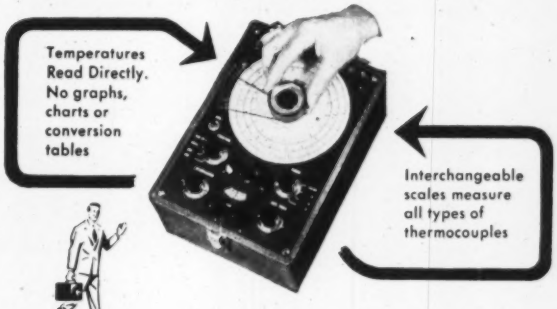
For this literature circle **405** on inquiry card.

FM Signal Generators

A modern narrow-band crystal-controlled receiver can be tested only with a Signal Generator having the following characteristics: (1) High frequency stability, (2) excellent signal/noise ratio, (3) precisely calibrated incremental frequency control, (4) accurate output down to 0.2 μv, (5) negligible leakage . . . Models 1066 and 1066/1 fulfill these requirements . . . Furthermore there are no sub-harmonics as the oscillator generates at fundamental frequency and the Marconi-patented contactless range turret eliminates RF contact maintenance . . . (*From new 6-page Leaflet "FM Signal Generators", Marconi Instruments, 44 New St., New York 4, N. Y.*)

For this literature circle **406** on inquiry card.

The only portable potentiometer pyrometer with interchangeable direct-reading scales


Temperatures Read Directly. No graphs, charts or conversion tables
Interchangeable scales measure all types of thermocouples

. . . checks and calibrates all types of temperature instruments.

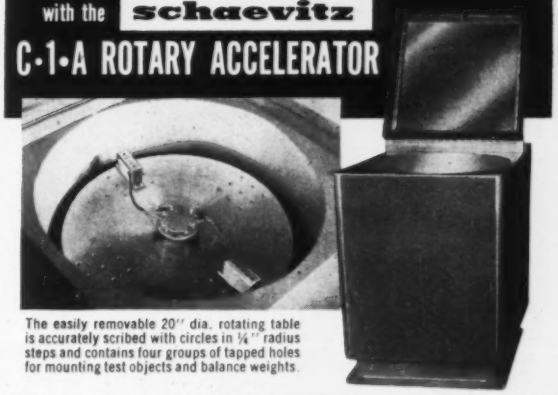
"Pyrotest" is the most versatile instrument of its type. Compact, rugged, easy to carry (12 lbs. . . . 12¼" x 9" x 8½"). Accurate to ¼ of 1%. 5 instruments in one—with a scale for every use, interchangeable in 30 seconds. Self-contained power supply. Write for free Bulletin 112.

TECHNIQUE

TECHNIQUE ASSOCIATES, INC.
211 E. SOUTH STREET
INDIANAPOLIS 25, IND.

For more information circle **123** on inquiry card.

TEST OR CALIBRATE SMALL ASSEMBLIES
with the schaevitz
C·1·A ROTARY ACCELERATOR



The easily removable 20" dia. rotating table is accurately scribed with circles in ¼" radius steps and contains four groups of tapped holes for mounting test objects and balance weights.

The small, compact, precisely-built SCHAEVITZ C·1·A Rotary Accelerator calibrates accelerometers and tests other small assemblies by subjecting them to multiples of the acceleration of gravity. The unit is ideally suited for use where space is at a premium. It does not require any special foundation for installation or any special skill for operation.

SPECIFICATIONS
ACCELERATION RANGE: 0-250 G at nominal 9" radius
SPEED RANGE: 0-1000 rpm
LOAD RATING: 3 lb. at max. G
SIZE OF TEST OBJECTS: 5" cube, nominal maximum
POWER REQUIREMENTS: 220 v, 60 cycle, 1 ph. a.c.
MOTOR CONTROL: Electronic, full-wave
SPEED CONTROL: 10-turn helical potentiometer
SLIP-RINGS: Eight, bronze, faced with coin silver
SPEED INDICATION: By means of a tachometer generator and meter. Auxiliary pickup for external frequency measuring equipment also supplied
OBSERVATION: Plexiglas window
SIZE: 2' wide x 2' 10" deep x 2' 8¾" high

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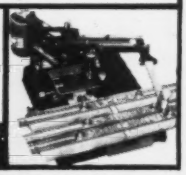

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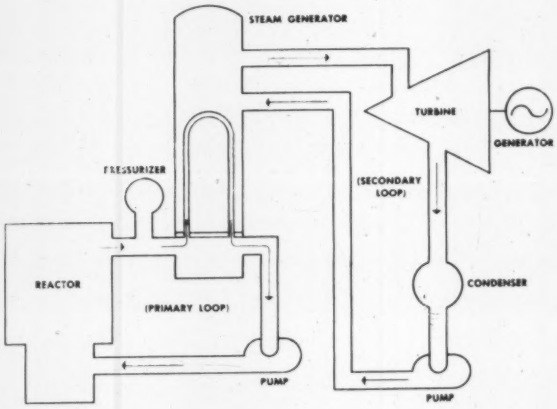
ALCO's pressurized water reactor is a practical answer to commercial installation requirements. Based on the Army's 2000-kilowatt Packaged Power Reactor now under construction at Fort Belvoir, Virginia, the basic design has been modified to provide up to 10,000 kilowatts or



more of power . . . The reactor is a heterogeneous, water-cooled and moderated reactor, employing enriched uranium clad in stainless steel . . . The pressurized water reactor design, as applied to a power plant, can furnish an efficiency in the range of approximately 22 to 26 percent . . . (*From new 12-page Bulletin "Power from the Atom," ALCO Products, Inc., P. O. Box 1065, Schenectady, N. Y.*)

For this literature circle **407** on inquiry card.

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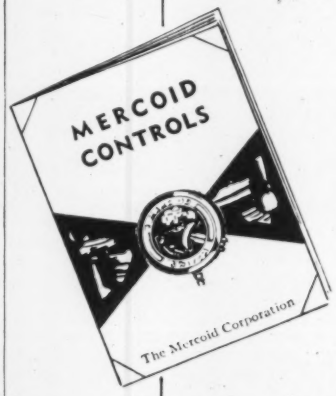

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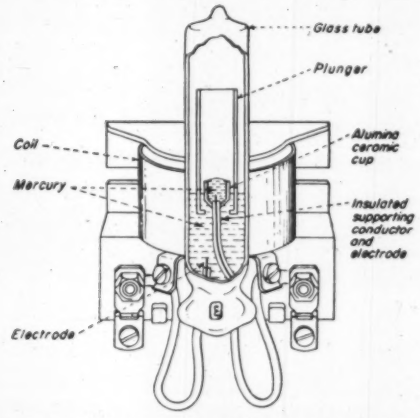
Mercury-plunger relays consist of a sealed tube containing the moving parts and contacts, a solenoid coil in which the tube is inserted, an assembly and mounting bracket, and a terminal board for the power connections . . . The sealed tube is hydrogen-filled and contains mercury and a ferro-magnetic plunger . . .

When the coil is energized the plunger is drawn down into the tube base, displacing the mercury upward and



over the top of the cup to make contact. Contacts for this type of relay are normally open. In the normally-closed type the plunger is weighted sufficiently to remain immersed in the mercury. When the coil is energized the plunger is drawn upward, the mercury drops below the level of the cup and the circuit is broken . . . (*From new 8-page Reprint, "Mercury Plunger Relays", Ebert Electronics Corp., Queens Village 28, N. Y.*)

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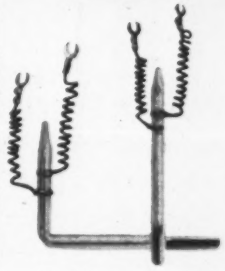
control temperature to .05°c WITH PRINCO THERMOSTATS



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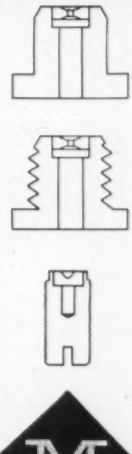

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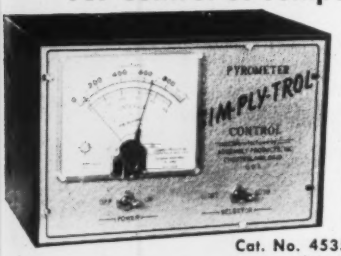

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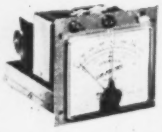

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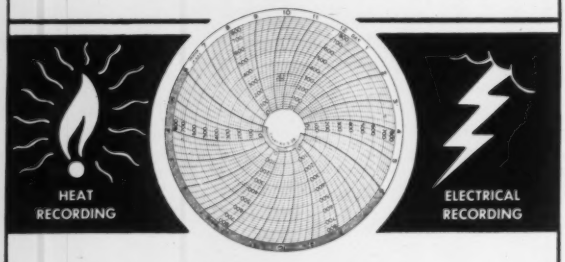

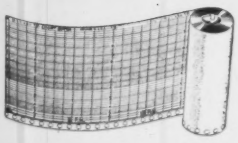

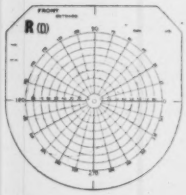

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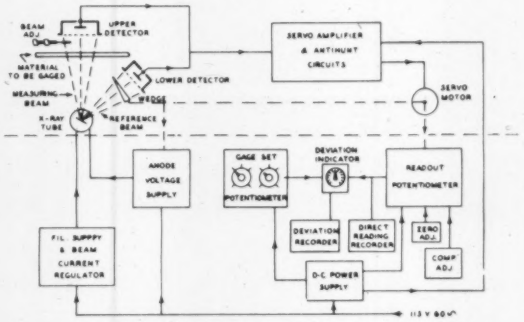
In the P&W X-Ray Gage, the X-ray beam is split; one beam goes through the material to be gaged and then to



an ionization chamber; the second beam passes through a movable wedge to another ionization chamber. The two chambers are directly connected and their ionization currents, which flow in opposite directions, are used to produce a signal. This signal drives a servo control which positions the wedge so as to obtain a complete balance between the two ionization chambers. The position of the wedge at balance is the measure of the thickness of the material being gaged . . . (*From new 12-page Catalog 600, Pratt & Whitney Co., Inc., Charter Oak Blvd., West Hartford 1, Conn.*)

For this literature circle **409** on inquiry card.

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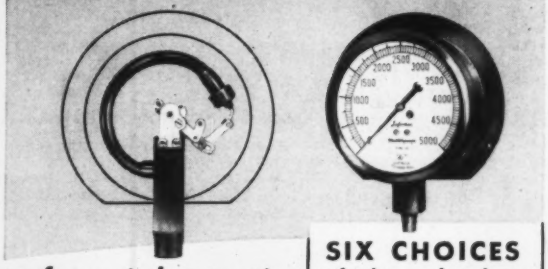

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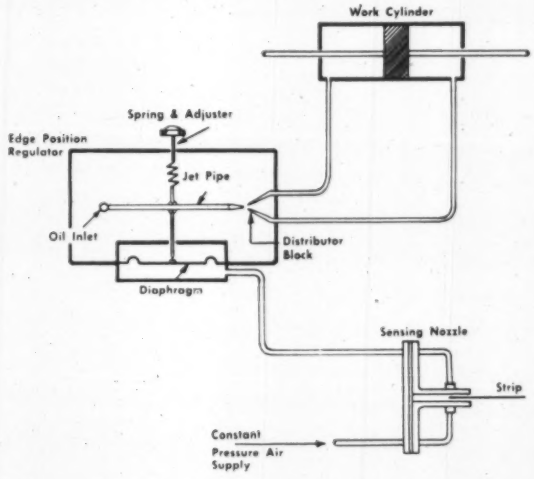
Fundamentally, the Askania Edge Position Control system transforms position errors into hydraulic force. As shown, the pivoted jet pipe is balanced between two forces—a light spring on one side and a force derived from the edge position signal on the other . . . If the edge of the strip moves from the required position, the jet



pipe shifts toward one opening, allowing more oil pressure to be recovered at one end of the work cylinder. The piston then moves to restore the edge of the strip to the required position . . . (*From new 8-page Bulletin* 33.1, *Askania Regulator Co.*, 240 *East Ontario St., Chicago* 11, *Ill.*)

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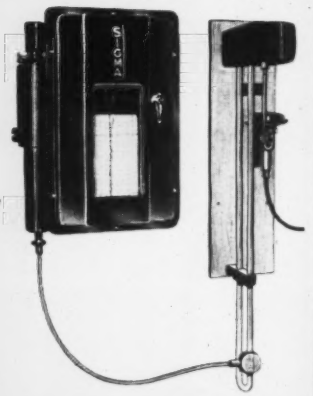

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A Franklin Dales Temp-Guard Thermostat is a completely self-contained circuit breaker that makes or breaks an electrical circuit by responding to changes in temperature or electrical load. It consists of a small tubular case containing a bimetal strip that deflects in response to changes in temperature or load, causing contacts within the case to close or separate (according to the design of the thermostat), making or breaking the electrical cir-

cuit . . . provides fast cycling with a ± 1 differential, or slow cycling with a ± 3 differential. Normal tolerance of ± 5°F can be reduced to ± 2°F on request . . . (*From new 8-page Bulletin "Temp-Guard Thermostats", The Franklin Dales Co., 180-184 East Mill St., Akron, Ohio.*)

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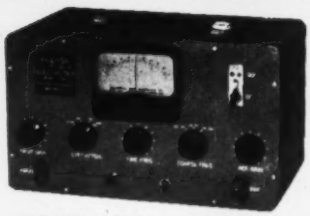

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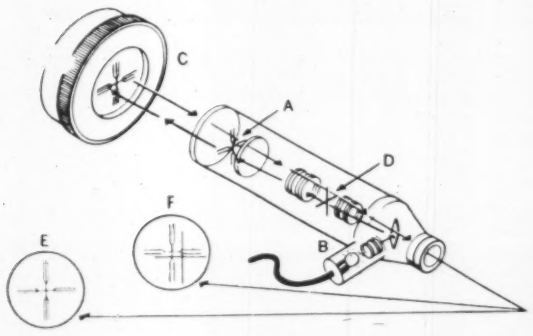

(or auto-reflection) is attained, the Transit telescope's line of sight is at precise right angles to the main reference line . . . (*From new 20-page Bulletin "Brunson Optical Tooling Instruments," Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.*)

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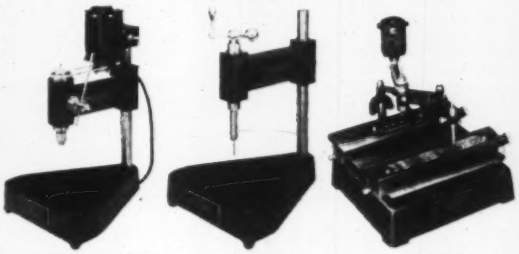

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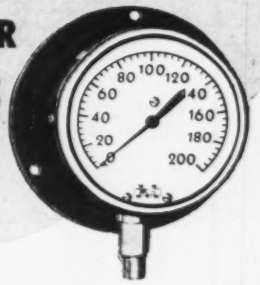

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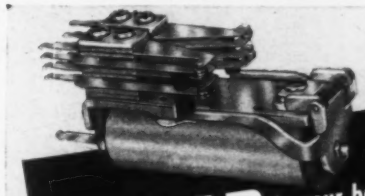

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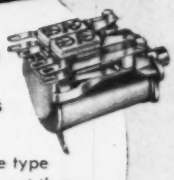

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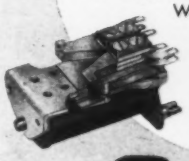

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INSTRUMENTS and AUTOMATION — New Literature

AUTOMATION

Metagraphic Instruments. New 4-page Bulletin A-126 describes maker's metagraphic panel instruments, including transmitters, receivers, and controllers.—Bristol Co., Waterbury 20, Conn.

Circle **414** on inquiry card.

Process Control Instruments. New 32-page Catalog 2 describes, specifies and gives prices of maker's process control instrumentation for flow, pressure, density, chlorination; ready for immediate shipment.—Fischer & Porter Co., Hatboro, Pa.

Circle **415** on inquiry card.

Entrainment Trap. New 2-page Bulletin 501 describes maker's "Mag-Pneu-Power" trap.—Hankison Corp., 951 Banksville Rd., Pittsburgh 16, Pa.

Circle **416** on inquiry card.

VALVES

Valves. New 2-page Bulletin 8264 describes operation of maker's two-way shut-off, direct acting, solenoid valves for cooling applications.—Automatic Switch Co., Orange, N. J.

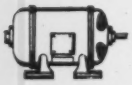
Circle **417** on inquiry card.

Air Valves. New 8-page Bulletin V-103 describes maker's ¼", ⅜" and ½" 4-way air valves for solenoid, foot or cam operation.—A. K. Allen Co., 57 Meserole Ave., Brooklyn 22, N. Y.

Circle **418** on inquiry card.

Valves. New 2-page Bulletin 23 pictures and describes maker's series of motor operated shut-off valves for high-pressure control functions.—Hydromatics, Inc., Cedar Grove, N. J.

Circle **419** on inquiry card.



MOTORS, SERVOS

Gear Motors. New 8-page Bulletin GEA-6133A presents data on maker's fractional horsepower gear motors.—General Electric Co., Schenectady 5, N. Y.

Circle **420** on inquiry card.

Telesyn Synchros. New 12-page brochure describes and illustrates maker's standard line of size 1, 3 and 5 Telesyn synchros.—Ford Instrument Co., Div. of Sperry Rand Corp., 31-10 Thomson Ave., Long Island City 1, N. Y.

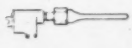
Circle **421** on inquiry card.

Converters. New 2-page Bulletin 1156A describes and illustrates maker's 750watt a-c rotary converter.—Carter Motor Co., 2711 W. George St., Chicago 18, Ill.

Circle **422** on inquiry card.

Motors. New 2-page bulletin describes maker's "Type FC" ac 400 cycle motors which can be wound either 3-phase, 2-pole or 4-pole; or 2-phase, 2-pole or 6-pole.—Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle **423** on inquiry card.



TEMPERATURE

Optical Thermal Device. New 12-page Brochure RD-515 pictures and describes maker's "Evaporograph" direct thermal imaging device.—Baird Associates-Atomic Instrument Co., 33 University Rd., Cambridge 38, Mass.

Circle **424** on inquiry card.

Cooling Detectors. New 4-page Bulletin MC-142 describes new aircraft cooling effect detectors (Series 18801) for protecting airborne electronic equipment against inadequate cooling conditions. Contains also data on operating principle.—Fenwal, Inc., Ashland, Mass.

Circle **425** on inquiry card.

Thermocouples. New bulletin presents miniature shielded thermocouples—copper-constantan, iron-constantan, and chromel-alumel for application in the temperature measurement of gases, and vapor mixtures of gases and liquids.—Thermo Electric Co., Inc., Rochelle Park Post Office, Saddle Brook, N. J.

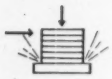
Circle **426** on inquiry card.

Contact Pyrometers. New 12-page Bulletin 4257 describes maker's "Alnor Pyrocon" contact pyrometer for surface temperatures. 2-page Bulletin 2569 specifies and prices Type R-4200 for wall mounting.—Illinois Testing Laboratories, Inc., 420 N. La Salle St., Chicago 10, Ill.

Circle **427** on inquiry card.

Temperature Regulators. New 4-page folder Section VII describes maker's "Series 650" self-contained temperature regulators.—Atlas Valve Co., 280 South St., Newark 5, N. J.

Circle **428** on inquiry card.



PRESSURE, WEIGHT

Pressure Pickup. New 2-page Bulletin 1572 presents procedure for securing repair service for maker's pressure pickups.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **429** on inquiry card.

Bagging Scale. New 6-page Bulletin 0256 describes with dimensional drawing maker's "FPA" open-type bagging scale.—Richardson Scale Co., Van Houten Ave., Clifton, N. J.

Circle **430** on inquiry card.

High-Vacuum Equipment. Six new 2-page Data Sheets 9-10, 9-25, 9-31, 9-55, 9-56 and 9-80 (with price list), describe maker's ionization gage control circuit, ionization gage tube, Pirani Gage, Autovac vacuum gage and McLeod Gage.—Includes 10-page CEC Bulletin P9-41 which decribes maker's discharge-type vacuum gage.—Consolidated Electrodynamics, Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Circle **431** on inquiry card.

Pressure Gage. New 4-page Bulletin DH-23 presents maker's line of pressure and chemical gages.—Helicoid Gage Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.

Circle **432** on inquiry card.

Probes. New 12-page brochure illustrates maker's miniature and standard temperature and pressure sensing instruments.—Aero Research Inst. Co., 315 N. Aberdeen St., Chicago 7, Ill.

Circle **433** on inquiry card.

Pressure Transducers. New 2-page leaflet describes maker's pressure transducers used for "Vanguard" earth satellite vehicle.—Rahm Instruments, Inc., 237 Lafayette St., New York 12, N. Y.

Circle **434** on inquiry card.

Remote Weighing. New 8-page Bulletin 0456 presents maker's new digital scanner system for recording or indicating weight in digital form at any remote location. Includes tape punch recording, and centralized batching control system.—Toledo Scale Co., Toledo, Ohio.

Circle **435** on inquiry card.

Load Cells. New "blue catalog" includes 7 bulletins with description and specifications of load cells for measuring tension and/or compression forces, etc.—Statham Labs., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

Circle **436** on inquiry card.

Force Gages. New 6-page Bulletin 750 describes maker's complete line of precision gages for tension or compression loads.—Hunter Spring Co. Apparatus Div., 1 Spring Ave., Lansdale, Pa.

Circle **437** on inquiry card.

TIME, SPEED

Time Indicators. New 2-page Bulletin A.W.H. ET 600 pictures and de-

scribes maker's basic elapsed time indicators (Series 7500, 12500, and 24200).—A. W. Haydon Co., Waterbury, Conn.
Circle **438** on inquiry card.

Cycle Timer. New 2-page Catalog TS-116 presents maker's 12-minute cycle repeating timer "Series C8301-S".—International Register Co., 2620 W. Washington Blvd., Chicago 12, Ill.
Circle **439** on inquiry card.

Hour Meters. New 8-page issue of "Hobbs Hour Meter Talks" (Vol. 9, No. 3) presents maker's line of hour meters for direct and alternating current.—John W. Hobbs Corp. Div., Stewart-Warner Corp., Springfield, Ill.
Circle **440** on inquiry card.

Tachometer. New 2-page bulletin pictures and describes maker's "Vibra-Tak" slide rule tachometer.—Verdell Instrument Sales Co., P.O. Box 212, Burbank, Calif.
Circle **441** on inquiry card.

FLOW, PUMPS

Rotameters. New 2-page bulletin lists outline and dimension drawings available from company.—Brooks Rotameter Co., Lansdale, Pa.
Circle **442** on inquiry card.

Controlled Volume Pump. New 4-page Bulletin 1056 describes and illustrates maker's sanitary-liquid-end controlled-volume pumps.—Milton Roy Co., 1300 E. Mermaid Lane, Phila. 18, Pa.
Circle **443** on inquiry card.

Electronic Eye System. New 2-page specification sheet presents specifications on maker's "Series S5" electronic eye systems.—Basic Controls Co., 4350 S. Sepulveda Blvd., Culver City, Calif.
Circle **444** on inquiry card.

Rotary Gear Pumps. New 14-page catalog presents design, performance and engineering data of maker's Nitralloy steel block pumps.—Northern Ordnance, Inc., Dept. 106, Columbia Heights Station, Minneapolis, Minn.
Circle **445** on inquiry card.

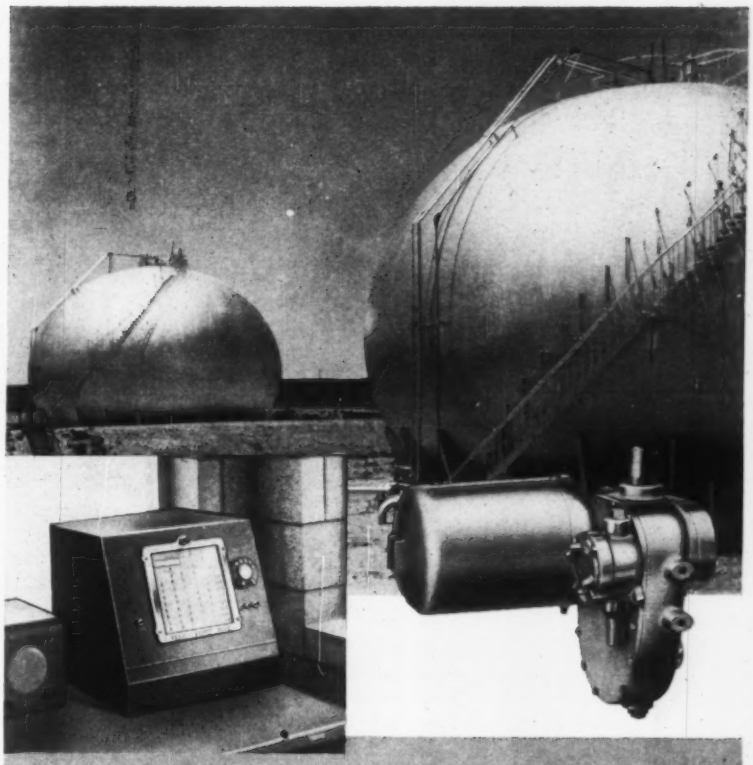
VISCOSITY

Viscometer Measuring Elements. New 2-page Bulletin V-1216 describes new line of electric-pneumatic viscometer measuring elements for 0.1 to 1 million centipoise.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass.
Circle **446** on inquiry card.

Viscometer. New 8-page catalog presents information on maker's "Synchro-lectric" viscometers.—Brookfield Engineering Labs., Inc., 240 Cushing St., Stoughton, Mass.
Circle **447** on inquiry card.

Microviscometer. New 2-page bulletin pictures and describes maker's sliding plate microviscometer for determining asphalt viscosity and durability.—Hallikainen Instruments, 1345 Seventh St., Berkeley 10, Calif.
Circle **448** on inquiry card.

Viscosity Meter—New 8-page issue of "Newsletter" (Vol. 3, No. 17) pictures and describes maker's Series 500 bubble viscometers for oils, varnishes etc.; also tube holders, glass aquar-



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NEW LITERATURE

ium type water bath, etc.—Gardner Lab., Inc., 5521 Landy Lane, Bethesda 14, Md.
Circle **449** on inquiry card.

RECORDERS

Oscillographs. New 2-page Bulletin 1536B presents two new explosion-proof modifications for maker's "Type 5-119" recording oscillograph.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.
Circle **450** on inquiry card.

Photo Equipment. New 104-page Catalog 956M presents list of maker's adapters, camera backs, exposure meters, projection screens, shutters, etc. —Burke & James, Inc., 321 So. Wabash Ave., Chicago, 4, Ill.
Circle **451** on inquiry card.

OPTICAL

Optical Instruments. New booklet presents illustrations and descriptions of maker's micro-alignment telescope, microptic auto-collimator. Contains also samples of tissues for cleaning such instruments.—Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.
Circle **452** on inquiry card.

X-Ray Microscope. New 16-page illustrated Bulletin 7A-3691 describes maker's x-ray microscope for industrial research and development.—General Electric Co., X-Ray Dept., Milwaukee 1, Wisc.
Circle **453** on inquiry card.

Gears and Splines Analysis. New 12-page Brochure HU-5448 features a study on optical analysis of gears and splines.—Jones & Lamson Machine Co., Springfield, Vt.
Circle **454** on inquiry card.

Industrial Periscopes. New 4-page Bulletin describes maker's industrial periscopes for remote observation of inaccessible places or hazardous processes.—Lenox Instrument Co. 2010 Chancellor St., Phila. 3, Pa.
Circle **455** on inquiry card.

Optics. New 1957 Catalog presents company's line of imported and domestic optical specialties such as prismatic binoculars made in Germany, France and Japan; field, opera and sport glasses; telescopes, microscopes, etc.—Compass Instrument and Optical Co., Inc., 104 East 25th St., New York 10, N. Y.
Circle **456** on inquiry card.

ANALYTICAL, LABORATORY

Gas Chromatography. New 4-page Bulletin 834 describes maker's fractionating columns and adsorbents for chromatographic analysis.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.
Circle **457** on inquiry card.

Photometer. New 24-page Brochure BP-1000B describes three "Brice-Phoenix" light-scattering photometers for determining high molecular weights and small particle size especially for turbidity measurements. —Phoenix Precision Instrument Co., 3803-05 N. Fifth St., Phila. 40, Pa.
Circle **458** on inquiry card.

Gas Analysis Cell. Two new Technical Data Sheets F84 describe maker's "Model 182" analysis cell used in gas chromatography.—Victory Engineering Corp., Springfield, N. J.
Circle **459** on inquiry card.

Polyethylene Ware. New 6-page Bulletin 35 presents information of maker's polyethylene ware for general laboratory use.—Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.
Circle **460** on inquiry card.

Marking Pen. New 1-page card illustrates maker's "Tech-Pen" that writes on virtually any surface with permanent ink in seven colors.—Gardner Lab. Inc., Bethesda 14, Maryland.
Circle **461** on inquiry card.

Connectors. New 4-page Bulletin 832 presents maker's series of connecting and valving devices used in gas, vapor and liquid flow systems.—Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.
Circle **462** on inquiry card.

Laboratory Furniture. New 12-page issue of "Lanco Apparatus News" (Vol. 8, No. 1) illustrates maker's line of steel lab furniture.—Arthur S. LaPine & Co., 6001 So. Knox Ave., Chicago 29, Ill.
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FREE SELECTION CHART for AGASTAT® time delay relays

Now you can select exactly the right Agastat time delay relay for your particular timing need—in a hurry. This free selection chart lists data on every popular model in the Agastat line—the most complete line of pneumatic time delay relays in the industry. They're adjustable for timing from 0.1 second to 10 or more minutes, unaffected by voltage variation, dustproof, light, and mountable in any position. And there's an Agastat model to precisely fit your requirements, including two-step, electrical interlock and double head units. A glance at the free selection chart tells you which model to order.

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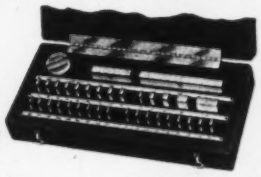

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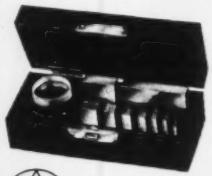

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Valve Burets. New 2-page bulletin pictures and describes maker's needle valve burets for titrations.—Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y.
Circle **464** on inquiry card.

Glassware Washers. New 2-page data sheet describes maker's portable washer for cleaning test tubes, flasks, burettes, etc.—Arthur S. LaPine & Co., 6001 South Knox Ave., Chicago 29, Ill.
Circle **465** on inquiry card.

Laboratory Equipment. New 8-page Bulletin 940 describes maker's columns of glassed-steel and alloy construction in tray and packed design. —Pfaudler Co., 1020 West Ave., Rochester 3, N. Y.
Circle **466** on inquiry card.

Stirrers, Mixers, Shakers. New 16-page illustrated Bulletin FS-264 describes maker's air-driven, electric, glass and magnetic stirrers; stirring electrodes; labmotors; blendor-type apparatus, etc.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Circle **467** on inquiry card.

Induction Furnace. New Bulletin describes maker's "Leco 500" induction furnaces.—Laboratory Equipment Corp., St. Joseph, Mich.
Circle **468** on inquiry card.

Specific Gravity Indicator. New 4-page Bulletin 7004 describes maker's remote reading non-mechanical specific gravity indicator No. 1561.—Petrometer Corp., 43-22 Tenth St., Long Island City 1, N. Y.
Circle **469** on inquiry card.

Analytical Balance. New 4-page bulletin describes features of Sartonius "Selecta" balances.—Distributor: Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.
Circle **470** on inquiry card.

Laboratory Ware. New 12-page Brochure PR-800 illustrates and tabulates the various styles and sizes of crucibles and dishes; also a full line of fabricated products made from the platinum group metals.—Metals & Controls Corp., General Plate Div., Attleboro, Massachusetts.
Circle **471** on inquiry card.

Spectrograph Chart. New revised X-ray Spectrograph Chart presents characteristic secondary X-ray beams for elements from Magnesium (Atomic #12) to Californium (Atomic #98).—North American Philips Co., Inc., 750 So. Fulton Ave., Mount Vernon, N. Y.
Circle **472** on inquiry card.

Seidel Calculating Board. New 2-page Bulletin SCB 10-56 presents Seidel Calculating Board for evaluating photometric data from spectrographic films and plates.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.
Circle **473** on inquiry card.

Laboratory Ware. New 16-page Bulletin P-965 presents a complete line of polyethylene ware for laboratory use—unbreakable, chemically inert, accident-reducing, inexpensive.—Scientific Glass Apparatus Co., Inc., Bloomfield, N. Y.
Circle **474** on inquiry card.

Chromatographic Apparatus. New 8-page Bulletin CHF-856 describes fourteen models of maker's chroma-

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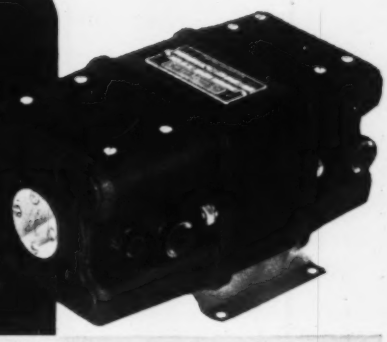

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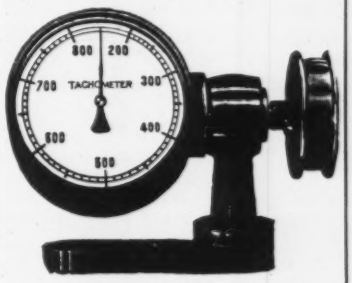

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NEW LITERATURE

tographic apparatus, and announces new two-week courses at Podbielniak Institute.—Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill.

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DATA PROCESSING

Computing System. New 9-page Form LSC-56,000 is an operational guide to new Univac Scientific 1103A electronic computing system; contains terminology list of instruction repertoire, and a keyed block diagram.—Remington Rand Univac Div. of Sperry Rand Corp., 1902 W. Minnehaha Ave., St. Paul, Minn.

Circle **476** on inquiry card.

Static Control System. New 8-page Bulletin GEA-6578 defines the fundamentals and features of general-purpose static control system for machine functions; list advantages, and describes its logic elements.—General Electric Co., Schenectady 5, N. Y.

Circle **477** on inquiry card.

Data Processing System. New 4-page publication "Data For Decision" provides a complete description, specifications and applications of the new "ALWAC 800" electronic processing system.—Logistics Research, Inc., 141 So. Pacific Ave., Redondo Beach, Calif.

Circle **478** on inquiry card.

Tape Handling Equipment. New 6-page brochure illustrates and describes a complete tape handling and storage system—reel trucks, files and storaways with stationary and portable racks.—TAB Products Co. of N. Y., 154 Nassau St., New York 38, N. Y.

Circle **479** on inquiry card.

Tape Control System. New 8-page Bulletin describes maker's punched-tape control system for automatic control of production machines.—Bendix Aviation Corp., Res. Labs. Div., 4855 Fourth Ave., Detroit 1, Mich.

Circle **480** on inquiry card.

Computer. New 4-page Application Data Report 1H-106 presents typical industrial situation resolved by G-15D general-purpose computer.—Bendix Computer Div., Bendix Aviation Corp., 5630 Arbor Vitae St., Los Angeles 45, Calif.

Circle **481** on inquiry card.

Delay Lines. New 16-page brochure presents specifications, definitions and measurements of maker's delay lines for computer and radar systems.—ESC Corp., 534 Bergen Blvd., Palisades Park, N. J.

Circle **482** on inquiry card.

STEAM, AIR

Steam Cleaner. New 6-page illustrated Bulletin describes maker's high precision desuperheater for removing dirt, and moisture from steam and compressed air.—Bradshaw & Co., 311 Ross St., Pittsburgh 19, Pa.

Circle **483** on inquiry card.

Air Cylinders. New 12-page illustrated Catalog 110 presents maker's line of "Series A" non-rotating air cylinders, valves and accessories.—S-P Mfg. Corp., 30201 Aurora Rd., Solon, Ohio.

Circle **484** on inquiry card.

TESTING, GAGING

Measuring Tools. New 2-page Bulletin (issue June-July 1956) presents maker's line of measuring tools and toolroom specialties.—George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

Circle **485** on inquiry card.

Non-destructive Testing. New 16-page Brochure 151 pictures and describes maker's "Magnaflux-Magnaflo" magnetic particle inspection system.—Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill.

Circle **486** on inquiry card.

Gages. New 4-page booklet describes maker's "Roll-Chek" gage for checking roll dimensions.—A. G. Davis Gage & Eng. Co., 21435 Dequindre Rd., Hazel Park, Mich.

Circle **487** on inquiry card.

Testing Machine. New 2-page Bulletin 106 describes and illustrates maker's lubricant testing machine "Model LFW-1".—Alpha Molykote Corp., 65 Harvard Ave., Stamford, Conn.

Circle **488** on inquiry card.

Calibrator. New 2-page Bulletin 210 describes and illustrates maker's torque wrench calibrator for setting and checking torque wrenches.—Skid-

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more-Wilhelm Mfg. Co., 442 Green Rd., Cleveland 21, Ohio.
Circle **489** on inquiry card.

Lead Testing Comparator. New 2-page bulletin pictures and describes maker's portable comparator for checking thread leads.—Jerpbak-Bayless Co., Solon Rd., Solon, Ohio.
Circle **490** on inquiry card.

Wear Tester. New 4-page Bulletin 166 describes heavy-duty wear tester for paints, linoleum, waxes, plastics, ceramics, etc.—Gardner Laboratory, Inc., 5521 Landy Lane, Bethesda 14, Md.
Circle **491** on inquiry card.

Test Equipment. New 32-page brochure describes and illustrates maker's humidity, fungus, temperature, altitude, sand and dust environmental test equipment.—Environmental Equipment Co., Brooklyn, N. Y.
Circle **492** on inquiry card.

Insulation Testers. New 4-page Bulletin 14-2 presents specifications on maker's "Model 424" dc hypots. Includes two 2-page Data Sheets 7 & 12 describing "Models 437 & 469" mobile type dc hypots.—Associated Research, Inc., 3758 W. Belmont Ave., Chicago 18, Ill.
Circle **493** on inquiry card.

Borescopes. New 16-page bulletin presents data and illustrated applications for maker's borescopes used for internal inspection through entry points as small as 0.1" dia.—National Electric Instrument Co., Inc., Elmhurst, N. Y.
Circle **494** on inquiry card.

Insulation Testers. New 4-page Bulletin 14-2 presents new portable d-c Hypots for simplified high-potential testing of dielectric strength and insulation resistance; also data sheets on mobile Models 437 and 469 having output voltage ranges of 0-70,000 V dc.—Associated Research Inc., 3766 W. Belmont Ave., Chicago 18, Ill.
Circle **495** on inquiry card.

Industrial X-ray Equipment. New 16-page Bulletin RC-176 presents maker's types of industrial radiography units—from a 60-KVP portable to a 300 KV constant potential unit; also accessories.—North American Philips Co., Inc., 750 So. Fulton Ave., Mount Vernon, N. Y.
Circle **496** on inquiry card.

COMMUNICATIONS

Communication Equipment. New 4-page Bulletin ECR-380-A describes maker's progress line of 450 mc two-way mobile radios.—General Electric Co., Electronics Park, Syracuse, N. Y.
Circle **497** on inquiry card.

MONITORS

Annunciator Systems. New 20-page catalog describes maker's self-policing visual and audible annunciator systems.—The Scam Instrument Corp., 1811 W. Irving Park, Chicago 13, Ill.
Circle **498** on inquiry card.

Monitor. New 4-page illustrated bulletin pictures and describes maker's impulse monitor for control or alarm; which requires no sensing element.—Damol Corp., 541 Land Title Bldg., Phila. 10, Pa.
Circle **499** on inquiry card.

Using stop motion, photographer Bernard Hoffman 'freezes' a tiny jet of water. Discharged at high pressure, the stream is a solid, unwavering mass.

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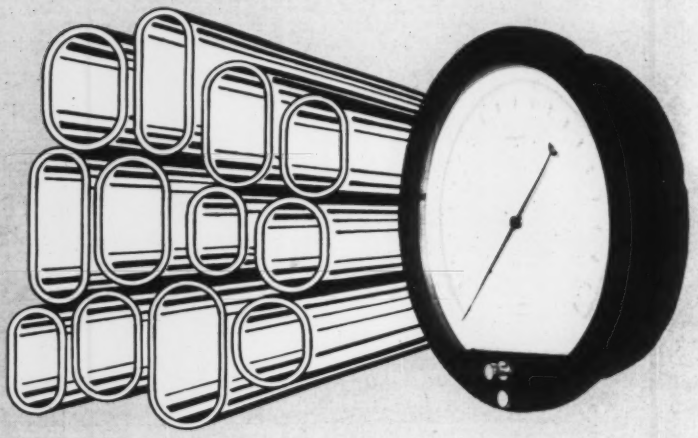

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For more information circle **147** on inquiry card.

NEW LITERATURE

TRANSISTORS

Silicon-Junction Rectifier. New 2-page Bulletin ECG-134A presents specifications and ratings of maker's silicon junction rectifier.—General Electric Co., Electronics Park, Syracuse 1, N. Y.

Circle **500** on inquiry card.

Junction Transistor. New 2-page Specification Bulletin G-3 describes maker's germanium P-N-P alloyed junction transistor for low frequencies.—General Transistor Corp., 130-11 90th Ave., Richmond Hill 18, N. Y.

Circle **501** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Beat Frequency Oscillator. New 28-page issue of "Bruel & Kjaer Technical Review" (November 1956), presents articles on a new beat frequency oscillator, automatic output regulator of beat frequency oscillator, and combined units.—Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio.

Circle **502** on inquiry card.

Galvanometers. New 12-page Bulletin 1528 describes and illustrates applications of maker's "Series 7-300" galvanometers and accessories.—Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **503** on inquiry card.

Tube Tester. New 2-page Bulletin CR5-290 describes maker's "Videochek Model CR5" TV picture-tube tester.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio.

Circle **504** on inquiry card.

Testing Instrument. New 2-page Bulletin describes maker's analyzer "141-A" used for testing Brown Electronik continuous balance amplifier units.—Parameters, Inc., 195 Herricks Rd., Garden City Park, New Hyde Park Post Office, N. Y.

Circle **505** on inquiry card.

Test Equipment Calibrator. New 2-page Bulletin pictures and describes maker's "Model 750" electric-test-equipment calibrator.—B & K Mfg. Co., 3726 N. Southport Ave., Chicago 13, Ill.

Circle **506** on inquiry card.

Miniature Voltmeters. New 2-page data sheet No. 239 presents description of maker's miniature ac voltmeter line with expanded scale.—International Instruments, Inc., P. O. Box 2954, New Haven 15, Conn.

Circle **507** on inquiry card.

Frequency Counter. New 4-page issue of "Hewlett-Packard Journal" (Vol. 7, No. 11-12) features article on new "A 0-1.1 MC Frequency Counter with Time Interval Markers".—Hewlett-Packard Co., 275 Page Mill Rd., Palo Alto, Calif.

Circle **508** on inquiry card.

Impedance Meters. New 2-page data sheet describes maker's coaxial and waveguide impedance meters.—Narda Corp., 160 Herricks Rd., Mineola, L. I., N. Y.

Circle **509** on inquiry card.

Digital Voltmeter. New 28-page Catalog 356 describes maker's digital voltmeter, and presents company's research and development facilities, etc. —Non-Linear Systems, Inc., Del Mar Airport, Del Mar, Calif.

Circle **510** on inquiry card.

Frequency Meter. New 2-page data sheet describes maker's "Model 802B" frequency meter.—Narda Corp., 160 Herricks Rd., Mineola, L. I., N. Y.

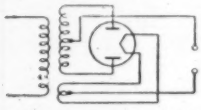
Circle **511** on inquiry card.

Analyzers, Recorders. Three new 4-page Bulletins 3A, 625 and 4A, describe and illustrate maker's TP-3A and TP-625 frequency analyzers, TP-4-A voltage level recorder, respectively.—Technical Products Co., Instrument Div., 6670 Lexington Ave., Los Angeles 38, Calif.

Circle **512** on inquiry card.

Electrical Kits. New 6-page folder presents maker's educational kits for self-teaching or demonstration of basic electronics, circuits, etc.—Crow Electri-Craft Corp., 1102 Shelby St., Vincennes, Ind.

Circle **513** on inquiry card.



POWER SUPPLIES

Power Supplies. New 4-page Bulletin B-568 presents dc voltage-regulated power supplies with specifications.—Kepco Labs., Inc., 131-38 Sanford Ave., Flushing 55, N. Y.

Circle **514** on inquiry card.

Power Supply. New 2-page catalog sheet explains the construction and operating principles of a specially filtered dc power supply—the Model "NFA"—for design testing and servicing radios and electronic equipment. —Electro Products Labs., 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle **515** on inquiry card.

Power Supply. New 2-page bulletin describes Series "Z-95000" power supplies used for maker's plug-in circuits. —EECO Production Co., 506 East First St., Santa Ana, Calif.

Circle **516** on inquiry card.

Power Supplies. New 36-page Catalog 57 presents specifications on maker's regulated power supplies for laboratory and industry.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

Circle **517** on inquiry card.

Saturable Reactors. New 4-page Bulletin 500 describes maker's saturable reactors for manual or automatic control of power to a load for industrial applications.—Hevi-Duty Electric Co., Milwaukee 1, Wis.

Circle **518** on inquiry card.

Power Supply. New 2-page bulletin presents specifications on maker's "Model U32-10" dc power supply.—Universal Electronics Corp., 1720 Twenty-Second St., Santa Monica, Calif.

Circle **519** on inquiry card.

ITV

ITV. New 64-page booklet presents wide selection of video, audio, lighting, etc. equipment for ITV and in-

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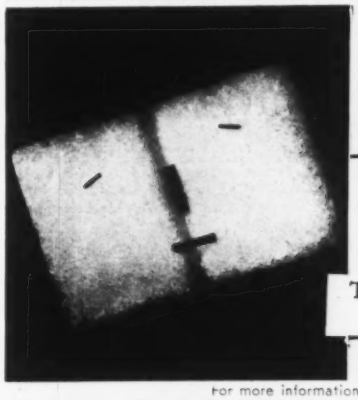
For more information circle **148** on inquiry card.



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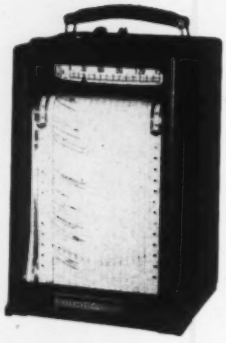

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NEW LITERATURE

cludes 15-page guide to types and accessories for particular applications, maintenance, etc.—Graybar Electric Co., Inc., 420 Lexington Ave., New York 17, N. Y.

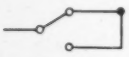
Circle **520** on inquiry card.

Closed-Circuit TV. New 28-page RCA High-Fidelity Television guidebook presents maker's line of color and black-and-white closed-circuit television systems.—Radio Corporation of America, 30 Rockefeller Plaza, New York 20, N. Y.

Circle **521** on inquiry card.

Industrial TV. New illustrated catalog presents maker's line of TV distribution units, installation accessories and closed-circuit TV equipment. —Blonder-Tongue Labs., 525-536 North Ave., Westfield, N. J.

Circle **522** on inquiry card.



SWITCHES, RELAYS

Precision Switches. New 12-page Catalog 5 pictures and specifies maker's precision switches for aircraft, industry and commercial use. Illustrates also special actuators.—Haydon Switch, Inc., 536 South Leonard St., Waterbury 20, Conn.

Circle **523** on inquiry card.

Switches. New 2-page Bulletin, and price list present specifications of maker's subminiature toggle switches. —Miniature Switch Corp., 3610 Oceanside Rd., Oceanside, L. I., N. Y.

Circle **524** on inquiry card.

Precision Switches. New 8-page Bulletin 84-222 describes maker's precision snap-acting switches for machine tools and industrial equipment. —Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **525** on inquiry card.

Enclosed Switches. New 24-page Catalog 77 pictures and describes maker's enclosed snap-acting switches for airborne equipment.—Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

Circle **526** on inquiry card.

Speed Sensor Relay. New 2-page Specification Sheet SSR-2.1 describes maker's "MEK-2060" speed sensitive relay.—Machinery Electrification, Inc., 35 Hudson St., Northboro, Mass.

Circle **527** on inquiry card.

Mercury Relays. New 2-page Leaflet describes maker's "Adlake Mighty Midget" relay.—Adams & Westlake Co., Elkhart, Ind.

Circle **528** on inquiry card.

Circuit Breakers. New 20-page Bulletin 3411 presents data on maker's hydraulic-magnetic circuit breakers. —Heinemann Electric Co., 551 Plum St., Trenton 2, N. J.

Circle **529** on inquiry card.

Steppers, Solenoids. New 16-page catalog presents company's stock list of steppers, solenoids, telephone type relays, miniature aircraft relays, stepping switches, etc.—Universal General Corp., 324 Canal St., New York 13, N. Y.

Circle **530** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

Components and Accessories. New 20-page Bulletin presents list of maker's knobs and spiral lacing, pulse transformers, test probes, viewing accessories, color filters, etc.—Allen B. DuMont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

Circle **531** on inquiry card.

Standard Knobs. New 16-page Catalog 106 presents specifications on maker's thermosetting plastic standard knobs.—Kurz-Kasch, Inc., Std. Parts Div., Dayton 1, Ohio.

Circle **532** on inquiry card.

Coil Forms. New 2-page Bulletin 1056 describes maker's precision moving-coil forms for d'Arsonval galvanometers.—H & H Machine Co., Noble & Jackson Sts., Norristown, Pa.

Circle **533** on inquiry card.

Breadboard Parts. New 8-page issue of "Helinews" No. 15 (November 1956), describes maker's standard electromechanical breadboard parts, linear scale ac ammeter and "Duodial" turns-counting dial.—Helipot Technical Information Service Corp., Div. of Beckman Insts., Inc., Newport Beach, Calif.

Circle **534** on inquiry card.

Logarithmic Converter. New 4-page bulletin describes maker's "Model 60" converter for dc or ac input voltages with output voltages proportional to logarithm of the amplitude of the input voltage.—F. L. Moseley Co., 409 N. Fair Oaks Ave., Pasadena 3, Calif.

Circle **535** on inquiry card.

Transformer. New 2-page Bulletin presents specifications on maker's miniaturized transistor transformer. —New England Transformer Co., Somerville, Mass.

Circle **536** on inquiry card.

Computer Accessory Equipment. Three new 2-page leaflets and a 4-page folder (Series 1-000) describes maker's servos, resolvers, recorders, "Model 108" three-channel instrument signal converter, etc.—Dynalysis Development Laboratories, Inc., 11941 Wilshire Blvd., Los Angeles 25, Calif.

Circle **537** on inquiry card.

Silicon Rectifiers. New 26-page Booklet ECG-148A gives full information on maker's Series 4JA60 small high-current silicon rectifiers.—General Electric Co., Semiconductor Products, Electronics Park, Syracuse, N. Y.

Circle **538** on inquiry card.

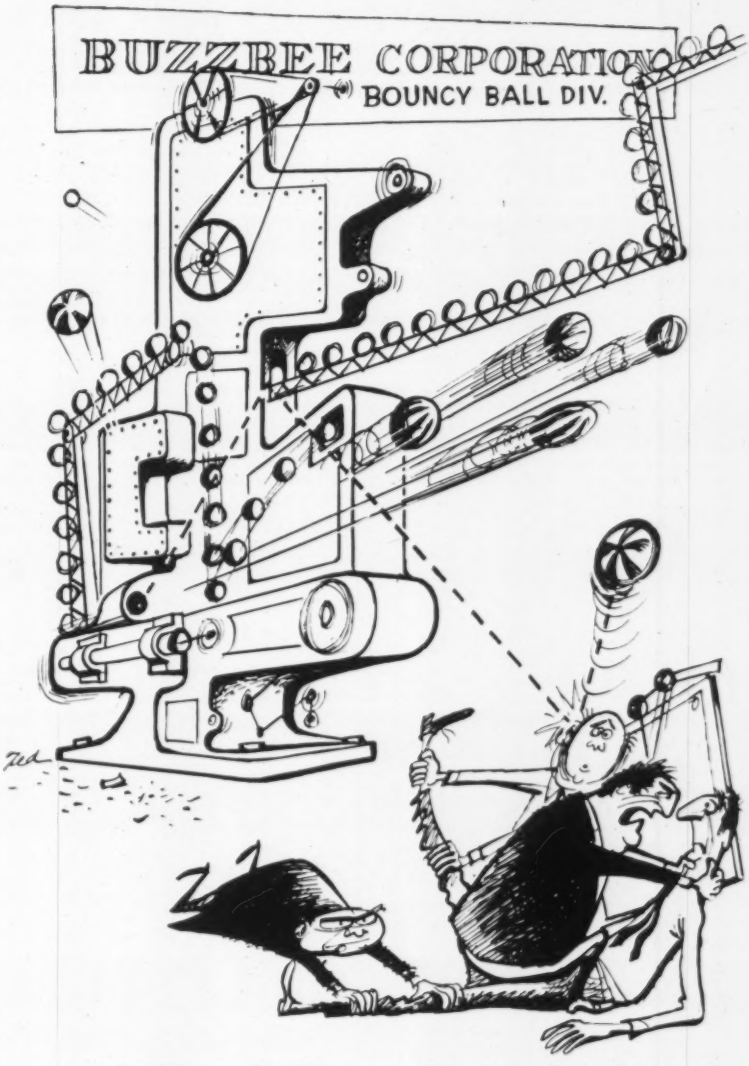
Core Laminations. New 6-page bulletin describes and specifies maker's "Type DU-1" magnetic core lamination.—Magnetics, Inc., Butler, Pa.

Circle **539** on inquiry card.

Miniature Lamps. New 8-page Catalog 101 presents data on maker's miniature incandescent lamps.—Hudson Lamp Co., 528 Elm St., Kearny, N. J.

Circle **540** on inquiry card.

Slip Ring and Brush Assemblies. Two new 2-page data sheets (101 and 102) describe maker's slip ring and brush assemblies; also lists prices.—Two new 2-page folders describes maker's sub-miniature slip rings; and sub-miniature rotary switches and



O.K... O.K..... So it's back to the old drawing board!... BUT THIS TIME REMEMBER AUTRON! **A·U·T·R·O·N!**

Mr. Buzzbee seems a bit put out at the output of his Bouncy Ball Div. His Chief Engineer seems to have been Nominated for Oblivion by Mr. B. His wrath is justified. For a long time, he has been screaming for a really reliable and small multi-purpose controller which would provide various options of control functions useable with a multitude of sensing elements for many farfetched applications. The upshot of this fateful scene is that the Buzzbee Chief Engineer shot up in Mr. B's. estimation by ordering a dozen of Autron's 6330 Heavy Duty Miniature Controllers. ($74 each, quan. 10-100.) If there's a Control Problem* in your life, you might need a 6330 too.

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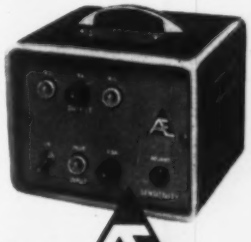
Model 6330 is a heavy duty miniature controller that answers the need for a compact, flexible and rugged electronic switch capable of receiving any one of a wide variety of inputs at very low voltage and power levels and delivering up to 500 watts of power to a controlled circuit.



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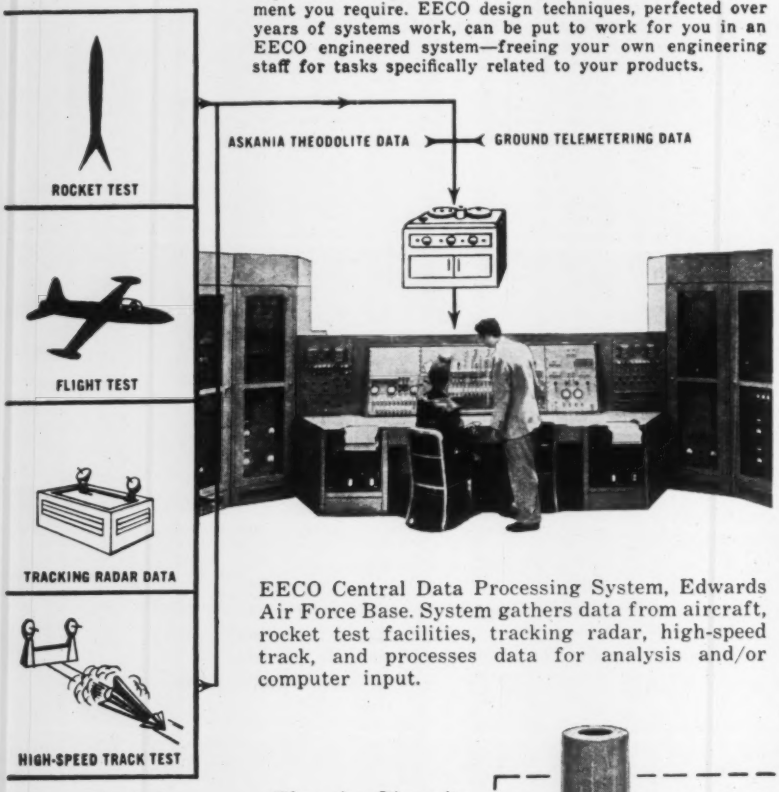

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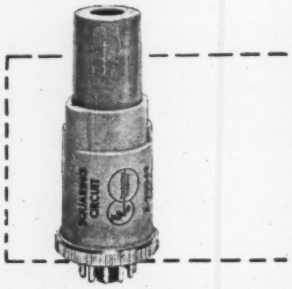

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NEW LITERATURE

brush holder assemblies.—Electro Development Co., 14701 Keswick St., Van Nuys, Calif.

Circle **541** on inquiry card.

Encapsulated Modular Units. New 4-page brochure describes "Rhomized" circuits which are rendered impervious to heat, cold, altitude and humidity by encapsulating the components.—Rho Engineering Co., 2242 Sepulveda Blvd., Los Angeles 64, Calif.

Circle **542** on inquiry card.

Composition Resistors. New 12-page Bulletin B-1A presents specifications, characteristics-charts, etc. of maker's "Type BT" fixed composition resistors.—International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

Circle **543** on inquiry card.

Resistors and Snap Switches. New 32-page Bulletin RC-10B describes maker's variable composition resistors and snap switches. Includes dimensional drawings.—Stackpole Carbon Co., St. Marys, Pa.

Circle **544** on inquiry card.

Potentiometers. New 2-page Technical Data Sheet 102 presents specifications on maker's minimalized trimmer potentiometers.—Carter Mfg. Corp., 23 Washington St., Hudson, Mass.

Circle **545** on inquiry card.

Ceramic Capacitors. New 20-page Catalog No. 616 specifies maker's TinyMIKE ceramic capacitors, including new temperature-compensating "Type C".—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

Circle **546** on inquiry card.

Electrolytic Capacitors. New 16-page Bulletin TMR-1 lists maker's single, dual, triple and quad, twist-mount, electrolytic capacitors designed for 85°C operation.—Pyramid Electric Co., North Bergen, N. J.

Circle **547** on inquiry card.

CONNECTORS, WIRE

Electrical Connections. New 4-page Bulletin RWS 146 presents information on wire strippers for electrical connections.—Rush Wire Stripper Div., The Eraser Co., Inc., Syracuse 4, N. Y.

Circle **548** on inquiry card.

Miniature Connectors. New 8-page issue of "Amphenol Engineering News" (Vol. 9, No. 7) describes maker's miniature AN-Type connectors.—Amphenol Electronics Corp., 1830 S. 54th Ave., Chicago 50, Ill.

Circle **549** on inquiry card.

Insulation Kits. New 4-page bulletin describes maker's cable splice insulating kits for use on 5,000 volts or less.—Acme Wire Co., New Haven, Conn.

Circle **550** on inquiry card.

Wiring Devices. New 8-page Brochure 856 describes maker's solderless wiring devices.—Electric Terminals Corp., 2021 Center St., Cleveland 13, Ohio.

Circle **551** on inquiry card.

TUBING, PIPE FITTINGS

Tube Fabricating Equipment. New 24-page Bulletin 1140 presents ma-

ker's line of hand tools, tube cutters, flarers, benders, etc.—Tube & Hose Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **552** on inquiry card.

Lubricating Compound. New 6-page Bulletin 15 MTF 56 describes maker's "T-Film" thread sealing and anti-seize compound.—Eco Engineering Co., 12 New York Ave., Newark 1, N. J.

Circle **553** on inquiry card.

Pipe, Fittings, Valves. New 8-page Bulletin CE-56 describes maker's "Ace Riviclor" plastic pipe fittings and valves.—American Hard Rubber Co., 93 Worth St., New York 13, N. Y.

Circle **554** on inquiry card.

Capillary Tube. New 2-page Bulletin CB 1056 presents specifications on maker's commercial copper tube, brasses, copper capillary tube, etc.—Wolverine Tube Div., Calumet & Hecla, Inc., Dept. 1, Guardian Towers, Guardian Bldg., Detroit 26, Mich.

Circle **555** on inquiry card.

Pipe, Tubing, Fittings. New 4-page Technical Data Sheet 146-A describes maker's "Croloy 5" steel pipe, tubing, and welding fittings.—The Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

Circle **556** on inquiry card.

Tubes. New 4-page bulletin describes maker's aluminum-alloy pointer tubing, metal-shielded wire, etc.—Uniform Tubes, Inc., Level Rd., Collegeville 2, Pa.

Circle **557** on inquiry card.

Flareless Tube Tool. New 2-page Data Sheet 1149-A5 pictures and describes maker's "Ferulset" tool for use in make-up of flareless type tube fittings.—Tube & Hose Fittings Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

Circle **558** on inquiry card.

MECHANICAL COMPONENTS

Instrument Components. New 132-page Catalog 11 presents stock list of over 4,000 precision instrument and servo parts.—PIC Design Corp. Div. of Benrus Watch Co., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle **559** on inquiry card.

Springs. New 8-page Bulletin 10M-8-56 presents fundamentals of spring design including basic stress and deflection formulas, commonly used spring materials, typical applications, and limitations for each of various types.—Associated Spring Corp., Bristol, Conn.

Circle **560** on inquiry card.

Press-Nut. New 2-page Bulletin R-312 pictures and describes maker's locked-in nut for sheet metal, aircraft, appliances, etc.—Rosan, Inc., 2901 West Coast Highway, Newport Beach, Calif.

Circle **561** on inquiry card.

Fasteners. New 4-page Catalog 7 presents maker's line of "Vibrex" multi-function fasteners. Includes 2-page bulletin on mounting of printed

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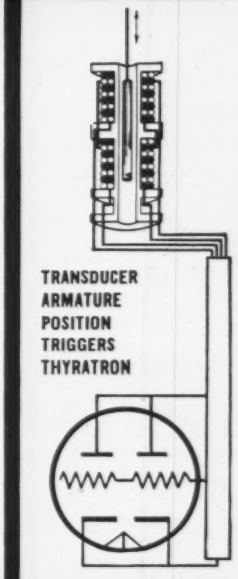

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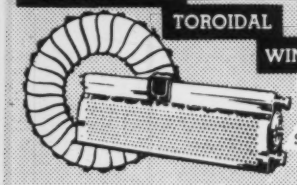

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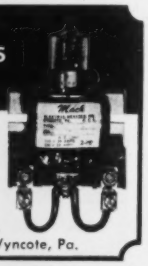

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circuits.—Vibrex Fastener Corp., Mount Kisco, N. Y.

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Components for Miniaturization. New 22-page Brochure 2132 describes methods of designing in the field of miniaturization featuring maker's micro set screws and fasteners.—Standard Pressed Steel Co., Jenkintown, Pa.

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Gear Reducers. New 2-page illustrated bulletin describes maker's Swedish style planetary gear reducers for ratios from 3.5:1 to 216:1.—Crichton Co., 1006 U. S. National Bank Bldg., Johnstown, Pa.

Circle **564** on inquiry card.

Nuts and Fasteners. New 8-page Catalog 516WR (with price list) describes maker's wrenches and tools for assembly of lock nuts and fasteners.—The Palnut Co., Glen Rd., Mountainside, N. J.

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FABRICATION

Forgings. New 8-page booklet "What is a Forging?" describes manufacture and uses of forgings. 6-page folder "Management Guide" furnishes information on closed-die forgings.—Drop Forging Association, 419 S. Walnut St., Lansing 33, Mich.

Circle **566** on inquiry card.

Surface Treatment. New 4-page bulletin describes company's processes for surface finishes on iron, steel, zinc, aluminum, etc.—New 4-page bulletin describes maker's "Electrofilm" solid film lubricants.—Pyro Metal Finishers, Inc., 10 Empire St., Newark 12, N. J.

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Miniature Threads. New 4-page catalog illustrates and prices miniature threads and tools for component, instrument, optical, jewelery manufacturers, etc.—J. I. Morris Co., Southbridge, Mass.

Circle **568** on inquiry card.

Lathe Accessories. New 6-page Bulletin R presents precision collets for jewelers type lathes, full line of turret tools for Levin lathes, including releasing tap and die holders with shock-free clutches.—Louis Levin & Son, Inc., 3610 So. Broadway, Los Angeles 7, Calif.

Circle **569** on inquiry card.

Screw-holding Driver. New 2-page bulletin presents maker's screw-holding driver in three sizes for setting and removing screws.—H. J. J. Co., 268 Marlow Drive, Oakland 5, Calif.

Circle **570** on inquiry card.

Production Facilities. New 4-page brochure describes company's production and research facilities.—Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y.

Circle **571** on inquiry card.

Industrial Furnaces. New 8-page Bulletin SC-175 illustrates maker's 27 standard rated surface heat treat furnaces.—Surface Combustion Corp., Toledo 1, Ohio.

Circle **572** on inquiry card.

Industrial Cleaning Machine. New 2-page leaflet describes maker's industrial cleaning machine.—L & R Mfg. Co., 577 Elm St., Arlington, N. J.

Circle **573** on inquiry card.

MATERIALS

Beryllium Copper. New 2-page bulletin gives information on maker's beryllium copper used as contact material in printed circuit connectors.—Beryllium Corp., P.O. Box 1462, Reading, Pa.

Circle **574** on inquiry card.

Polyester Laminate. New 4-page chart D-10-25-56 presents electrical and physical properties of maker's fiberglass-reinforced polyester laminate.—The Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio.

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Plastic Laminates. New 8-page illustrated booklet describes maker's "Lamicoid" plastic laminates for charts, dials etc.—Mica Insulator Co., P.O. Box 1076, Schenectady 1, N. Y.

Circle **576** on inquiry card.

Metals. New 12-page Catalog PR-700A pictures and describes maker's clad, thermostat, solid and clad precious, and industrial metals.—Metals and Controls Corp., General Plate Div., Attleboro, Mass.

Circle **577** on inquiry card.

Laminated Plastic. New 4-page Comparator Chart NVF-6550 gives property ratings of 34 grades of laminated plastic and vulcanized fibre.—National Vulcanized Fibre Co., 1056 Beech St., Wilmington 99, Dela.

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Beryllium Copper. New 4-page Bulletin 8 presents heat treat recommendations for producing maximum

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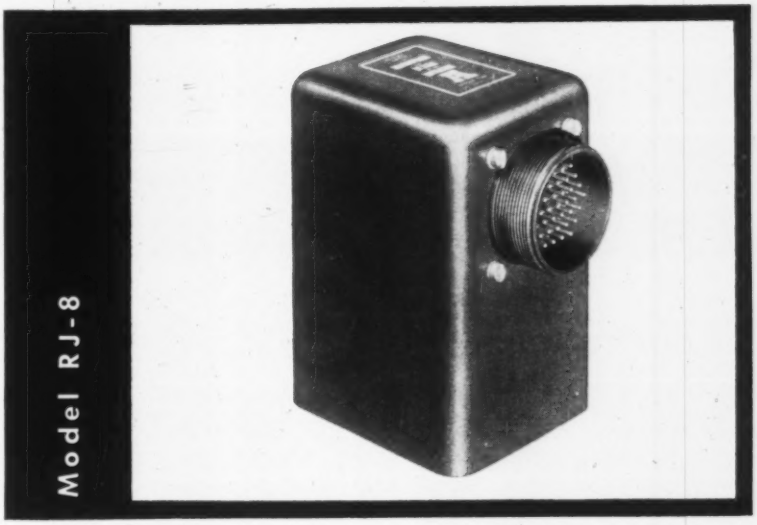

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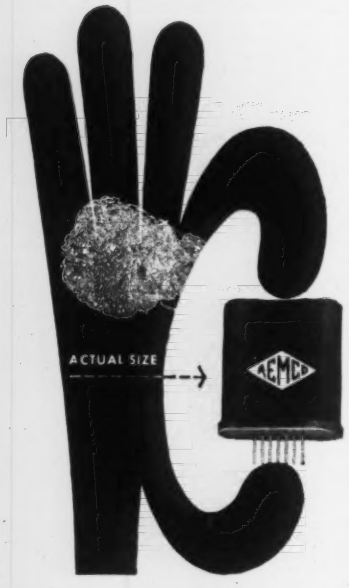

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strength and hardness in beryllium copper strip.—Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa.

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Ferrite Material. New 2-page bulletin "Digest of Approximate Properties" of maker's "Type R-151" ferrite for S- through K-Band frequencies in Faraday rotation devices.—Raytheon Mfg. Co., Ceramic Sales, Foundry Ave., Waltham 54, Mass.

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Silicone Products. New 12-page Reference Guide 1-112 describes maker's silicone products.—Dow Corning Corp., Midland, Mich.

Circle **581** on inquiry card.

Lubricant. New 8-page brochure describes maker's "Permawick" combination oil-and-cellulose base fibre lubricant.—Fluidwick Co., 5319 E. Outer Drive, Detroit 34, Mich.

Circle **582** on inquiry card.

Cleaning Solvent. New 12-page booklet describes maker's "Immunol" non-alkaline, non-acid detergent and rust preventive solvent for cleaning, degreasing and rustproofing metal surfaces.—Harry Miller Corp., 4th & Bristol Sts., Phila. 40, Pa.

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MISCELLANEOUS

Copper Alloys. New 2-page Data Sheet presents tabulation of non-standard, wrought copper base alloys.—Copper & Brass Res. Association, 420 Lexington Ave., New York 17, N. Y.

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Kiln Instrumentation. New 16-page Folder N-0720 (1) "Modern Practices in Rotary Kiln Instrumentation" presents applications of maker's instruments and controls in manufacture of cement, lime and other non-metallic products.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

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Water Demineralizer. New 4-page bulletin describes and illustrates maker's constant flow "Quikpure-Unibed" water demineralizer for laboratory and/or industrial uses.—Boder Scientific Co., 810-814 Penn Ave., Pittsburgh 22, Pa.

Circle **586** on inquiry card.

Static Cleaning. New 6-page leaflet No. 8-56 describes, illustrates, and prices three "Staticmaster" models for cleaning surfaces of dust, lint, etc.—Distributed by Gardner Laboratory, Inc., P.O. Box 5728, Bethesda 14, Md.

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Activated Charcoal. New catalog describes use of activated charcoal for air recovery, odor removal, air purification, food preservation and solvent recovery.—Pur Air Div., Barnebey-Cheney Co., Columbus, Ohio.

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Standardization. New 40-page survey contains up-to-date version of original edition of 1951 with 79 documented case studies covering 27 industrial fields.—American Standards Associations, 70 East 45th St., New York 17, N. Y.

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Window Units. New 4-page Bulletin 4D describes maker's circular window

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NEW LITERATURE

units used to observe internal operations, indicate flow, or internal liquid level, etc.—Bijur Lubricating Corp., Rochelle Park, N. J.

Circle **590** on inquiry card.

Instrument Cases. New 60-page Catalog 856SL tabulates maker's complete line of drawn and fabricated aluminum, brass and steel instrument cases for electronic and instrument manufacturers.—Zero Mfg. Co., 1121 Chestnut St., Burbank, Calif.

Circle **591** on inquiry card.

Corrosion Measurement. New brochure presents specifications on maker's "Corrosometer" for measuring corrosion directly in penetration units. Contains charts of 13 actual tests. —Crest Instrument Co., 11808 S. Bloomfield, Santa Fe Springs, Calif.

Circle **592** on inquiry card.

Filters. New 2-page Issue of "Poro-Scope" presents maker's hydraulic filters.—Pall Filtration Companies, Glen Cove, N. Y.

Circle **593** on inquiry card.

Control Panels. New 2-page Bulletin PAN 1156 describes maker's floor, wall or generator-mounted control panels.—Kato Engineering Co., 1415 First Ave., Mankato, Minn.

Circle **594** on inquiry card.

pH Meters, Dehydrators. New 12-page Brochure presents list of maker's refrigeration, air conditioning equipment, boiler and heating systems, etc.—Berna Corp., Garwood, N. J.

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Activating Machine. New 6-page Folder MDF-11 describes maker's mechanical activator for applying adhesive to nameplates.—Miller Dial & Name Plate Co., 4400 N. Temple City Blvd., El Monte, Calif.

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Facility Information. New 16-page brochure presents facility information on company's equipment, principal personnel, management, etc.—Frank R. Cook Co., Denver, Colo.

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Pocket Calculator. New 4-page bulletin illustrates and describes operation of pocket calculator that rapidly multiplies, divides, adds and subtracts. —Utility Supply Co., 641 W. Lake St., Chicago 6, Ill.

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Uranium Fluorimeter. New 4-page bulletin describes maker's uranium fluorimeter for assaying uranium minerals in the laboratory.—Mount Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo.

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Shipping Boxes. New 24-page Booklet 8 describes modern methods in designing corrugated shipping boxes.—Hinde & Dauch, Sandusky, Ohio.

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Scientific & Engineering Tables. New 116-page brochure presents first supplement to company's booklet "Selected Scientific and Engineering Tables and Data"—United States Testing Co., Inc., 1515 Park Ave., Hoboken, N. J.

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Fluid Drives. New 16-page illustrated Bulletin 9119 presents maker's line of "Gyrol" fluid drives for ½ to 25 hp applications.—American Blower Corp., Hydraulic Coupling Div., Detroit 32, Mich.

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Brazing Alloys. New 4-page Bulletin 22 describes handy Hi-Temp Brazing Alloys . . . for high-strength bonding of stainless steel, steel, Inconel, copper and other metals which have melting temperatures above the flow points of these brazing alloys.—Handy & Harman, 82 Fulton St., New York 38, N. Y.

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Panelboards. New 16-page Bulletin No. 1-160 describes improved industrial and commercial panelboards; plug-in molded case circuit breakers and enclosures for lighting and power distribution.—Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J.

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Glass-Metal Sealed Assemblies. New 4-page bulletin presents custom-made glass-to-metal sealed assemblies such as multiple headers, custom assemblies, pressure terminals, etc.—Farnsworth Electronics Co., Pacific Div., 815 San Antonio Rd., Palo Alto, Calif.

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Mylar Adhesives. New 8-page Technical Bulletin 17 describes three new types of adhesives for Mylar film.—E. I. Du Pont de Nemours & Co., Inc., Wilmington 98, Del.

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Engineering Services. New 8-page folder describes extensive tool, die and machine design; production engineering and product design and development services for industrial and metalworking plants.—Engineering Service, Inc., 21460 W. Eight Mile Rd., Detroit 19, Mich.

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Electronic Potting Compounds. New 15-sheet loose leaf folder presents maker's large line of electronic embediments, plastic foams, laminating and impregnating resins, casting resins, coatings, plastic and fiber glass laminates, as well as engineering services.—Electronic Plastics Corp., 675 Barbey St., Brooklyn 7, N. Y.

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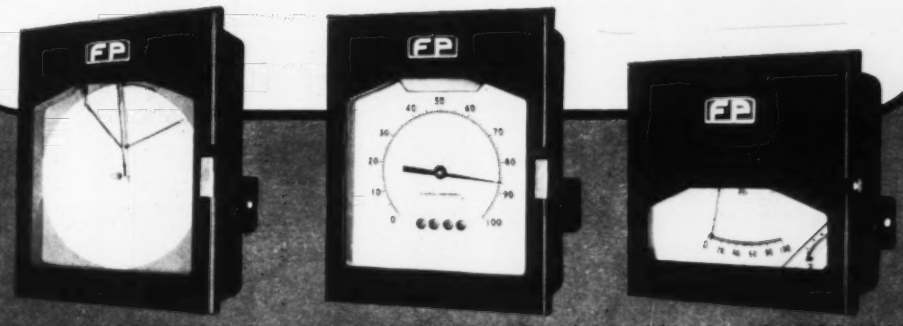

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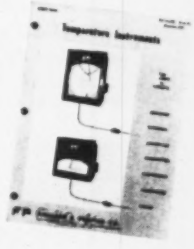

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